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Electronic Navigational Chart (ENC) Updating Study: Final Report

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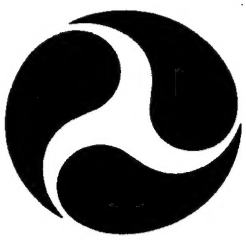

Final Report
January 1998

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for

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16. Abstract

This report summarizes the work performed by the USCG Research and Development Center from 1994 to 1997 in the area of electronic chart updating. The first objective of this effort was to determine the impact of electronic navigational chart updating on the U. S. Coast Guard infrastructure that provides paper chart corrections. The second objective was to examine and suggest modifications to three international standards involved with updating the electronic navigational chart (ENC).

Field trial testing was conducted to evaluate international standards and provide feedback for their development. A prototype display system was developed to test display concepts and gather mariner input. A prototype electronic chart update (ECU) was developed to evaluate information and technology requirements for producing electronic chart updates.

From our sea trial testing we developed and tested a method for displaying colors and symbols for manual updating of electronic charts. This method was adopted by the international community and incorporated into the standards.

The prototype ECU makes use of the IHO S57 standards. The function, content, and format of the ECU proved to be an acceptable replacement for the USCG Local Notice to Mariner (LNM). The ECU bridges the gap between the current LNM structure and the S57 standard by providing the update in a format which is computer friendly and human readable. This study also determined that the current Aids to Navigation Information System and LNMs do not have the capability to support the ECU or other Electronic Chart System updating requirements.

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Electronic Navigational Chart (ENC), Electronic Chart Display and Information System (ECDIS), Electronic Chart System (ECS), Local Notice to Mariners (LNM), electronic chart updating, International Hydrographic Organization (IHO), IHO Standards, IHO S57, International Maritime Organization (IMO), IMO Standards	This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161.

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UNCLASSIFIED	UNCLASSIFIED		

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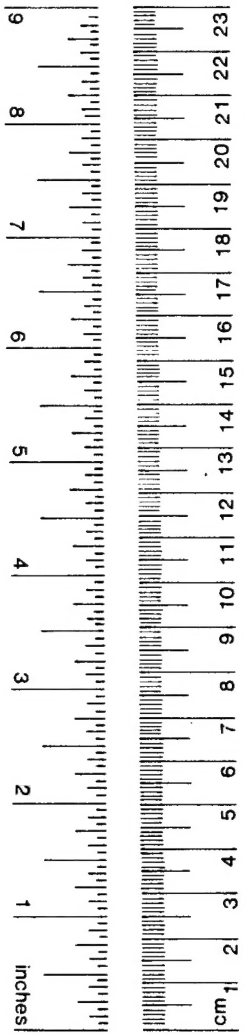
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	* 2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (WEIGHT)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (EXACT)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (WEIGHT)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (EXACT)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

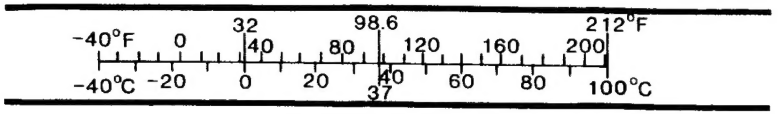


TABLE OF CONTENTS

APPENDIX A- A description of the chart update data, graphics, and performance measures used during sea trial tests designed to evaluate the IMO Draft Performance Standard for ECDIS.

APPENDIX B - A description of the USCG's Aids to Navigation Information System.

APPENDIX C - A description of the functional requirements for the R&D Center's Local Notice to Mariners - ECDIS Revision (LNM-ER) prototype software.

APPENDIX D - A description of the process for creating an LNM-ER from ATONIS.

APPENDIX E - A test plan describing the issues and options tested using the prototype display tool.

APPENDIX F - A description of the USCG R&D Center's implementation of the IHO S57 and S52 standards on the prototype display system. This appendix includes the prototype display system program specifications and software design document (PS/SDD).

APPENDIX G- A list of IHO S57 objects and attributes.

APPENDIX H- The database schema developed in Microsoft Access designed to store the parsed IHO S57 data structure.

APPENDIX I - A description of the prototype electronic chart update (ECU) file format and examples of four ECU actions (i.e. add, delete, change, and relocate).

APPENDIX J - Field Trial Testing Instruments used during the evaluation of the IHO standards:

- INSTRUCTIONS - for performing the test and operating the prototype display system (pages J-1 to J-9)
- DEFINITIONS/ACRONYMS - to define electronic chart updating terminology (pages J-11 to J-12)
- A COPY OF THE INTERACTIVE QUESTIONNAIRE IMBEDDED IN THE PROTOTYPE DISPLAY SYSTEM (pages J-13 to J-21)
- A COPY OF THE INTERACTIVE DIRECTIONS/COMMENTS IMBEDDED IN THE PROTOTYPE DISPLAY SYSTEM (pages J-23 to J-25)
- THE ACTUAL ECU USED - several variations of the ECU were used to test the effectiveness of different formats (output from ECU Generator, Appendix J pages J-27 through J-38).

APPENDIX K - A detailed analysis of questionnaire responses collect during the field trial tests developed to evaluate the IHO standards on ENC updating.

TABLE OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

4GL	Fourth Generation Language. A 4GL uses human understandable text phrases to define source code.
ATONIS	Aids To Navigation Information System.
BNM	Broadcast Notice to Mariners.
BTOS®	Operating System for the BTOS line of work stations.
Catalog file	Contains information relating to entire S57/DX90 exchange set, relationships between record.
CTOS®	Convergent Technologies Operating System. A proprietary computer operating system.
CGSW	Coast Guard Standard Workstation.
C. G. District They are:	The Coast Guard has nine districts in the United States of America. District 1 Boston, Massachusetts District 5 Portsmouth, Virginia District 7 Miami, Florida District 8 New Orleans, Louisiana District 9 Cleveland, Ohio District 11 Long Beach, California District 13 Seattle, Washington District 14 Honolulu, Hawaii District 17 Juneau, Alaska
Description file	Contains information relating to entire S57/DX90 exchange set, datum scale accuracy of data.
DB	Database.
DBMS	Database-Management-System.
DDR	Data Descriptive Record.
DOS®	Disk Operating System. Synonymous with MS-DOS®.
DX90	International Hydrographic Organization's transfer standard (IHO S57/DX90).
ECDIS	Electronic Chart Display and Information System.

ENC	Electronic Navigational Chart.
Feature object file	Contains the actual objects, attributes and attribute values to be transferred, spatial object model.
Fiscal Quarter	October 1 to December 31 January 1 to March 31 April 1 to June 30 July 1 to September 30
IHO	International Hydrographic Organization.
IMO	International Maritime Organization.
LNM	Local-Notice-to-Mariners. A weekly and monthly publication detailing critical marine information (such as chart corrections).
LNM-ER	Local Notice to Mariners - ECDIS Revision information. Digital data updating the ENC, as defined in chapter 2 of S-57 part B.
LNM-NC	Local Notice to Mariners - Nautical Chart. Digital data supporting the generation of a nautical chart.
NIMA	National Imagery and Mapping Agency (formally the Defense Mapping Agency - DMA)
NIS	The Navigation Information Service.
NOAA	National Oceanic and Atmospheric Administration.
NOS	National Ocean Service.
OAN	Coast Guard District Office of Aids to Navigation.
RDBMS	Relational Data Base Management System.
R&DC	U.S. Coast Guard Research and Development Center.
S52	Special Publication 52 - IHO chart content and display aspects of ECDIS.
S57	Special Publication 57 - IHO transfer standard for digital hydrographic data (DX90).
SENC	System Electronic Navigational Chart.
USCG	United States Coast Guard.

EXECUTIVE SUMMARY

The responsibility for establishing, maintaining, and notifying the public about aids to navigation in waters of the United States is legislated to the United States Coast Guard (USCG). With the advent of electronic charts, there is an increasing demand for electronic chart updates. The USCG realized this need and began a three year effort in 1994 to investigate various aspects surrounding electronic chart updating. This report summarizes the work performed by the USCG Research and Development Center (R&D Center) on this effort.

There are three specific international standards involved in this work. All three describe various aspects of Electronic Chart Display and Information System (ECDIS). The International Maritime Organization (IMO) Performance Standards for ECDIS [IMO, 1995] describes the functionality required in an ECDIS. The International Hydrographic Organization (IHO) Special Publication 57 (S57) - The Transfer Standard for Digital Hydrographic Data [IHO S57, 1993] was developed as the data format for official electronic navigational charts (ENCs). IHO Special Publication 52 (S52) is the Specifications for Chart Content and Display Aspects of ECDIS [IHO S52, 1995]. It is used by the ECDIS to properly translate the ENC into a consistent display of colors and symbols for the operator. Only when a system complies with these standards can it be called an ECDIS. If a system does not comply with these standards, then by default it becomes an Electronic Chart System (ECS).

The first objective of this effort was to determine the impact of electronic navigational chart updating on the USCG infrastructure that provides paper Local Notice to Mariners. The second objective was to examine and improve the three international standards mentioned above as they relate to updating the electronic navigational chart (ENC).

We conducted field trial testing to evaluate international standards and provide feedback for their development. We developed a prototype display system to test display concepts and gather mariner input. We also developed a prototype electronic chart update (ECU) to evaluate information and technology requirements for producing electronic chart updates.

The prototype ECU can serve as a single source of updates for ECDIS, ECS and paper chart users. The ECU makes use of the IHO S57 standards. The ECU also uses the objects and attributes given in the S57 model to implement updates. The ECU bridges the gap between the current USCG Local Notice to Mariner (LNM) structure and the S57 objects and attributes (official ENC data) by providing the update in a format which is computer friendly and human readable. However, we also determined that current USCG Aids to Navigation Information System (ATONIS) and LNMs do not have the capability to support the ECU or other future ECDIS updating requirements. We found technical limitations in the data contained in ATONIS and format problems in the LNM report.

Our work on the development of the ECU has led us to conclude that the IHO standard S57 can provide the Coast Guard with a ready made structure for defining and building an aids to navigation database that can support Local Notice to Mariners for paper chart users and electronic chart users. Due to its international scope, this standard provides compatibility and understanding world wide. The use of S57 in a USCG Aid to Navigation Database System would provide the ability to transfer chart corrections information to the National Oceanic and Atmospheric Administration (NOAA) and the National Imagery and Mapping Agency (NIMA) to

update their portfolio of charts, and to mariners for manually updating their charts.

From our sea trial testing, we determined that an electronic chart must have an uncluttered but distinguishable display for viewing updates. Vector data proved to be very useful, while raster overlay was shown to cause clutter. We also determined that the function, content, and format of the ECU proved to be an acceptable replacement for the LNM. Additionally, we developed and tested a method for displaying colors and symbols for manual updating, which was adopted by the international community and incorporated into the standards. Enough information has been gathered through our tests to indicate that the handling of time varying information (e.g. tides, currents, weather, identification and location of other ships) will be possible in the future.

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1. INTRODUCTION

The United States Coast Guard (USCG), is the lead maritime agency responsible for establishing and maintaining aids to navigation in U. S. waters. This responsibility extends to notifying the public about the condition of these aids and other pertinent information about the waterways. Much of the information in these notices modifies information contained in nautical charts. The nautical charts in use today are primarily paper charts. With advances in computer technology and geographical information systems over the last few years, electronic charts are slowly beginning to supplement paper charts for marine navigation. In order to understand the requirements for updating the electronic chart (i.e. providing electronic chart notices) and the impact of this requirement on the present USCG infrastructure that supports the use of paper charts only, the USCG, in 1994, began a three year project to investigate this requirement. This report summarizes the work performed by the USCG Research and Development Center (R&D Center) in their investigation.

1.1 BACKGROUND

In the U. S., updates to paper charts are published weekly as "Local Notice to Mariners (LNM)" by the USCG for use by all types of vessels. The National Imagery and Mapping Agency (NIMA), uses the LNMs to publish "Notice to Mariners (NTM)" for military and deep draft vessels. Information concerning navigation hazards and local navigation information are broadcast by the USCG as required in each individual harbor as "Broadcast Notice To Mariners".

Electronic chart display and information system (ECDIS) is a navigation information system which integrates positional information from navigation sensors on to an electronic chart to assist a mariner in route monitoring and route planning. The hydrographic information (i.e. chart) that is used by an ECDIS is the electronic navigational chart (ENC). International standards for ECDIS specify the format and content of the ENC as well as how the ENC must be displayed on the ECDIS. In this way, manufacturers can design the ECDIS to properly read and manipulate the ENC and mariners using ECDIS will be provided with functionality and ENC display features that are similar from ECDIS to ECDIS, independent of manufacturer.

In order for ECDIS to achieve its fullest potential, the ENC must contain the latest information (i.e. any changes to the hydrographic information that might have accrued since it was first distributed). Responsibility for maintaining up-to-date charts lies with the user. This holds true for both paper charts and electronic charts [Evangelatos, et al, 1992]. The process through which a mariner manually or the ECDIS automatically applies these updates, is critical and should be simple and straight forward. The presentation of these chart corrections/updates is very important. Cluttering the display with distracting information may lead to navigation errors [Gonin and Dowd, 1995].

Since the first draft of the International Maritime Organization (IMO) Provisional Performance Standards for ECDIS was published in 1989 [IMO Provisional, 1989], a number of experiments have been performed to address the issue of broadcasting updates to the ECDIS aboard the ship. "The Seatrans Project" performed by the Norwegian Hydrographic Service in 1991, concluded that automatic updates of ENC data were possible using Inmarsat satellite communications. However, ENC data sets were found to be quite large for satellite communications which use data rates of 600 bit/sec. Norwegian Hydrographic Service recommended that several Regional Centers perform global updates. Government involve-

ment would help to guarantee a consistent, standardized, continuous and dependable updating service for ENCs [Seatrans, 1991]. "The Netherlands ECDIS Project" performed by the Netherlands Hydrographic Service in 1991 concluded that Inmarsat-C could be used to update the ENC [Netherlands, 1991].

Later research has focused on problems associated with different approaches to handling automatic updates of the ENC [Evangelatos, et al, 1992] including various processes [Langran, 1992] and formats for broadcasts [Sushko, 1993]. The German Ministry of Transport Hydrographic Office performed automatic chart updating sea trials in conjunction with the Baltic and North Sea ECDIS Testbed Project called the BANET Project. Results from this experiment helped to develop draft specifications for ENC updating [BANET, 1994].

1.2 OBJECTIVE

One objective of this effort was to determine the impact of Electronic Navigational Chart (ENC) updating on the USCG infrastructure that provides paper Local Notice to Mariners. This consisted of evaluating the capability of the USCG Aids to Navigation Information System (ATONIS) to support ENC updating. Understanding the results of this evaluation and the impact it might have on the USCG's ability to provide an ENC updating service was also an important goal of this effort.

A second objective was to examine and suggest modifications to three international standards involved with updating the ENC. In 1994, IMO was in the process of developing a draft performance standard for ECDIS [IMO Draft, 1994]. It contained a section which very broadly discussed provisions for updating chart information. This broad discussion was an appropriate place to begin the examination of ENC updating.

The IMO Performance Standard for ECDIS is often considered the umbrella standard for ECDIS because it specifies numerous other standards which detail the technical specification for ECDIS. Two particular references are standards developed by the International Hydrographic Organization (IHO). These standards contain specifications for the format and structure of the ENC and the display requirements for the ENC. In order to better understand the issues surrounding updating the ENC, it was necessary to understand these standards.

- IHO Special Publication 57 (S57) is the Transfer Standard for Digital Hydrographic Data [IHO S57, 1993]. It contains the structure and format for describing hydrographic data. The Electronic Navigational Chart (ENC) is a database which is standardized in content, structure and format, and contains all the chart information necessary for safe navigation. The ENC is the chart data used by the ECDIS.

- IHO Special Publication 52 (S52) is the Specifications for Chart Content and Display Aspects of ECDIS [IHO S52, 1995]. It contains three Appendices:

    - Appendix 1 - Guidance on Updating the Electronic Navigational Chart (ENC)
    - Appendix 2 - Colour and Symbol Specifications for ECDIS
    - Appendix 3 - Glossary of ECDIS-related Terms

At the time work began on this effort (i.e. 1994), these standards were in various states of development. The IMO Performance Standard for ECDIS was in draft form. The S57 standard was on it's second edition. The IHO S52 Appendix 1 was in an outline stage. Appendices 2 & 3

were in their second edition.

1.3 ORGANIZATION OF REPORT

This report begins with an examination of the IMO Draft Performance Standard for ECDIS, Section 4, Provisions and Updating of Chart Information. An experimental ECDIS was used in sea trials to evaluate this broad standard and determine the capabilities and limitations of present technology as it applies to updating the ENC.

The report then moves to a discussion of the work performed to examine the more detailed specifications outlined in the IHO S57 and S52 standards on updating the ENC. In this section the feasibility of using ATONIS and LNM to support ENC updating is discussed. There is a discussion of the prototype display system developed for field trial tests. There is a discussion of prototype software developed to bridge the gap between the production of USCG LNM for paper charts and the production of electronic chart updates.

This report ends with a Conclusion section and References. Also found at the end of this report are references to the following appendices which provide additional information on various topics touched upon throughout this report.

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APPENDIX K - A detailed analysis of questionnaire responses collected during the field trial tests developed to evaluate the IHO standards on ENC updating.

2. EXAMINATION OF THE INTERNATIONAL MARITIME ORGANIZATION (IMO) PERFORMANCE STANDARDS FOR ECDIS, SECTION 4, PROVISIONS AND UPDATING OF CHART INFORMATION

A sea trial test was designed to examine several broad issues underlying the IMO Draft Performance Standard Section 4, Provisions and Updating of Chart Information [IMO Draft, 1994]. Such issues as:

- examining the types of requirements and possible methods for ECDIS to accept, apply, and display automatic and manual updates to the ENC.

- examining the various methods to distinguish manual updates on the display from ENC information and automatic updates without affecting display legibility.

This test was also designed to investigate more global updating issues such as system implementation, information transfer, and new approaches for handling electronic updates. There had been little prior experience with updating the ENC, particularly with manual updating. ECDIS standards committee members were concerned with the difficulty of implementing a user friendly updating process for mariners to use that would be safe and effective. Experience was needed in this area. A better understanding of bandwidth requirements (i.e. update file size) and integrity requirements (i.e. validation) for automatic updating was also needed.

2.1 APPROACH

2.1.1 EQUIPMENT

An experimental ECDIS was developed under the U. S. ECDIS Testbed Project. This experimental ECDIS was designed to meet or exceed the IMO Provisional Performance Standards for ECDIS [IMO Provisional, 1989]. The hardware and software was developed by Intergraph Corporation. This system consisted of an INTERGRAPH 2400 UNIX-based workstation running experimental ECDIS software and configured with dual-monitors. This experimental ECDIS was integrated with a navigation sensor package, cellular telephone and modem aboard the motor vessel (M/V) KINGS POINTER. (See Figure 2-1).

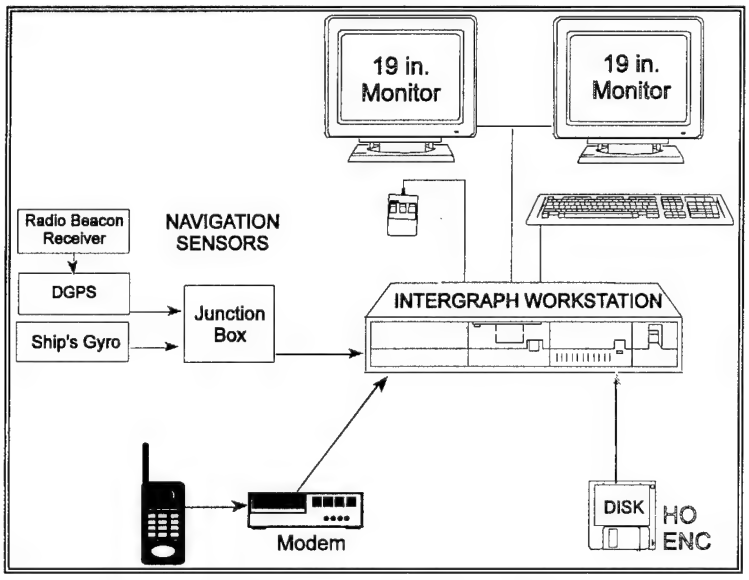

Figure 2-1 Equipment Configuration

NOAA created prototype IHO S57 chart data set, which was used by the experimental ECDIS as an ENC. This data set consisted of paper chart number 12366, Long Island Sound and East River, in the vicinity of the USMMA (scale - 1:20,000), and several sections of neighboring charts in one data set. This was done to demonstrate to the mariner the concept of

a seamless database.

2.1.2 METHODOLOGY

The symbology and format for manual and automatic updates were developed jointly by USCG and National Oceanic and Atmospheric Administration (NOAA). The user interface, system requirements, and processes for implementing these updates were developed by USCG, NOAA, and Intergraph. For this phase of the effort, it was decided that only the simplest form of updates would be implemented (i.e. point objects such as: buoys, point soundings, wrecks, lights). In this way more energy could be spent on the broad implications of ENC updating.

When testing began, each mariner was immersed in the issues surrounding the updating of the ENC. First, the mariner answered a pre-questionnaire about general background information and personal experience with updating paper charts. Next, the mariner was introduced to the sea trial test plan [Gonin, et al, 1994], objectives of the experiment, and procedures. Each mariner was then trained on specific chart updating features of the experimental ECDIS and then went through the process of applying a variety of updates. A debriefing questionnaire about the process, procedures and symbology, of performing manual and automatic updates on the experimental ECDIS was filled out. Finally, a post-sea trial questionnaire was completed with more general questions about possible enhancements, limitations, and training requirements surrounding electronic chart updating. Approximately five hours were spent with each mariner. For a description of the chart update data, graphics, and performance measures used during these sea trial tests see *APPENDIX A*

2.1.3 SUBJECTS AND SEA TRIAL TEST AREA

Participants included United States Merchant Marine Academy (USMMA) and State University of New York Maritime College, cadets, mates, masters and pilots. Several pilots from the Northeast Pilots Association and Delaware Pilots Association also participated. In all, 14 mariners took part. Sea trials took place over a six week period in April and May 1994 in the area of New York Harbor aboard the USMMA M/V KINGS POINTER.

2.2 RESULTS

Table 2-1 shows summary statistics of age and experience of the mariners. The majority of the mariners were experienced and had some familiarity with computers and electronic charts. These traits were helpful for this sea trial test because many new concepts surrounding marine navigation were introduced on the ECDIS. Familiarity with computers and electronic chart systems were also important because the experimental ECDIS was designed to evaluate the standards and not specifically designed for use by mariners on the bridge of a ship. The keyboard and selection menus were complex and awkward. Many of the mariners were able to differentiate between the experimental nature of the system and computer technology limitation in general.

Table 2-1 Summary Statistics of Pre-Questionnaire

Mariner Summary Statistics	Number of Mariners Out of 14
Performed passage planning regularly	7
More than a medium familiarity with computers	11
Experience with any type of electronic chart	10
Correct paper charts regularly (weekly)	11
On average spend one to two hours correcting paper charts	11
Agree that correcting paper charts was not difficult, but time consuming & tedious	14
More than 15 years experience as licensed mariners	9
Under the age of 50	14

Although our sample size was small, there were differences reported between mariner age groups. Mariners between the ages of 40 to 49 reported: medium familiarity with computers; and slightly less difficulty learning how to operate the experimental ECDIS as compared to age group 30 to 39. Mariners between 40 and 49 years of age were the most confident of all age groups in using ECDIS for chart corrections. All mariners in this age group were practicing pilots or masters with considerable experience. As the most experienced mariners, they seemed able to look beyond many of the complexities inherent in this experimental ECDIS. This group tended to follow the written directions more closely then the mariners in the 30 to 39 age group which tended to apply their own knowledge of computers and overlook some of the written directions. Mariners in the 40 to 49 age group also seemed most aware that the technology surrounding electronic charting was very valuable and would become a significant navigation tool in the future.

All the mariners tested felt that both the manual and automatic update procedures implemented on the experimental ECDIS for this test, could not be done while on watch. Eleven out of 14 mariners stated the process interfered with route monitoring. They felt that the implementation of manual updates was too time consuming to perform. They felt that the automatic function applied the updates to the ENC quickly, but it took too long to initiate the connection and download of the data from the bulletin board service. Even when obtaining the data from the floppy, it took too long to transfer the data to the proper directory for access by the ECDIS. These limitations, however, were found to be implementation related rather than technology related because the experimental ECDIS was designed specifically to evaluate the standards, rather than to perform as a shipboard navigation system with a user friendly interface.

Figure 2-2 summarizes the mariners' responses to when and where chart updates are normally applied to a paper chart. One mariner indicated that corrections are made whenever there is information received which is different from what is presently indicated on the chart and that electronic charts should be as flexible. However, the majority of the mariners most often correct paper charts during ***open water passage***, ***dockside*** and ***route planning***. ***Coastal waters*** also seemed to be a common area to apply chart corrections.

There were mixed responses from the mariners concerning symbols. They felt that the symbology for manual updating could be improved and made to stand out less on the display, yet still be distinguishable as required by the standards. Many suggestions were recorded and evaluated in the lab following the sea trial test. In general, they felt the colour orange was appropriate to identify chart corrections.

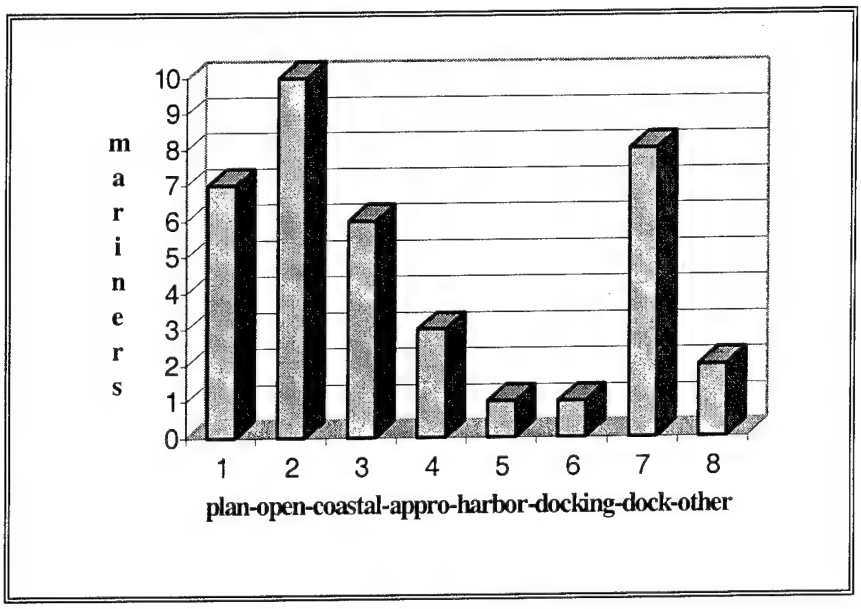

Figure 2-2 When and where are chart updates applied?

Validation of updates was important to the mariners. They felt that they should have final review of updates, even if they are automatically acquired and processed by the ECDIS. The use of temporarily highlighting the updates to review them was found to be a useful requirement. They also indicated that in time, this validation may need to be less and less extensive as confidence in the process and infrastructure supporting electronic chart updates is established.

All the mariners tested felt that MANDATORY training of mariners will be needed to implement electronic chart updating. Implementation may require training on manual and automatic updating, issues surrounding sources for this data, the use of modems, wireless Internet access, and computers in general.

2.3 SUMMARY

A wealth of feedback concerning many issues surrounding electronic chart updating was received. Generally, the mariners tested agreed with the requirements given in the IMO Draft Performance Standards for ECDIS on ENC updating. A new proposal for symbology for manual updates was recommended to IHO for further investigation and the standards requirement to provide a capability to highlight updates proved to be a valuable feature. The structure and format of S57 automatic updates produced rather large files, as was determined by the Seatrans Project [Seatrans, 1991] and the Netherlands ECDIS Testbed Project [Netherlands, 1991]. Enough evidence had been gathered to form an IHO Database Working Group tasked to develop a more robust format and structure for ENC updating. The mariners were comfortable using a cellular phone and modem to receive electronic updates, and the idea of satellite communications or the Internet were also acceptable means for information transfer. Their only concern was that the mechanism be consistent from port-to-port. This information was passed to the ECDIS standards committees.

The results of this sea trial test helped to lay the foundation for the standards committees to more fully define the technical specifications for ENC updating. The next several sections of

this report discuss the work done in this effort which was designed to assist in the continued development of these specifications.

3. EXAMINATION OF THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) GUIDANCE ON UPDATING THE ENC - A FEASIBILITY STUDY ON CREATING ENC UPDATES FROM USCG LOCAL NOTICE TO MARINERS (LNM)

The objective of this feasibility study was to determine if, and to what extent, the USCG's Aid to Navigation Information System (ATONIS) database, version 2.0, is capable of supporting Electronic Navigational Chart (ENC) updating requirements. One function of ATONIS is to produce Local Notice to Mariners (LNM) for users of paper charts. The format and structure of the LNM was designed for a human to read and understand. In the electronic charting arena, updates to the electronic chart must have the capability to be computer readable. This section discusses the investigation of the USCG R&D Center during the period of October 1, 1994 to March 31, 1995 concerning the capabilities of ATONIS in supporting ENC updating.

3.1 APPROACH

This effort focused on determining if ATONIS could create updates to the ENC. The approach taken was to:

- perform an initial review of data contained in the ATONIS database and information flow within ATONIS,
- determine the requirements to update an ENC as specified in IHO S57 (i.e. Transfer Standard for the Exchange of Digital Hydrographic Data).

This led to the design for a possible system that could support ENC updating. This system design would need to be implemented as a prototype to determine if it could successfully produce an ENC update. The system developed was called the Prototype Local Notice to Mariner - ECDIS Revision (LNM - ER). Figure 3-1 describes the design of the existing LNM process and the prototype LNM - ER design.

In the existing LNM process, each USCG District receives information about changes to the waterways from the Army Corps of Engineers, NOAA, USCG units, mariners and others on a daily basis. The districts collect this information on the USCG's Standard Workstation II using the ATONIS program. This ATONIS program is written in a forth generation programming language called PROGRESS. PROGRESS is also used as the user interface to ATONIS. Once a week, districts compile the daily changes into a LNM Report. This report is distributed to a variety of users. See *APPENDIX 2 - DESCRIPTION OF ATONIS,* for a more detailed discussion on ATONIS.

On the right side of Figure 3-1 is the Prototype LNM-ER design. The S57 object and attributes translation database is needed to produce the LNM-ER by translating the ATONIS chart corrections information into IHO S57 information. This database uses the structure and content called out in the S57 standard to describe hydrographic information (i.e. buoys). This database can be manipulated by the same user interface used by the ATONIS database. The goal was to have ATONIS output a human readable report for updating the ENC manually and the LNM-ER in the S57 format to be used by the ECDIS to automatically update the ENC.

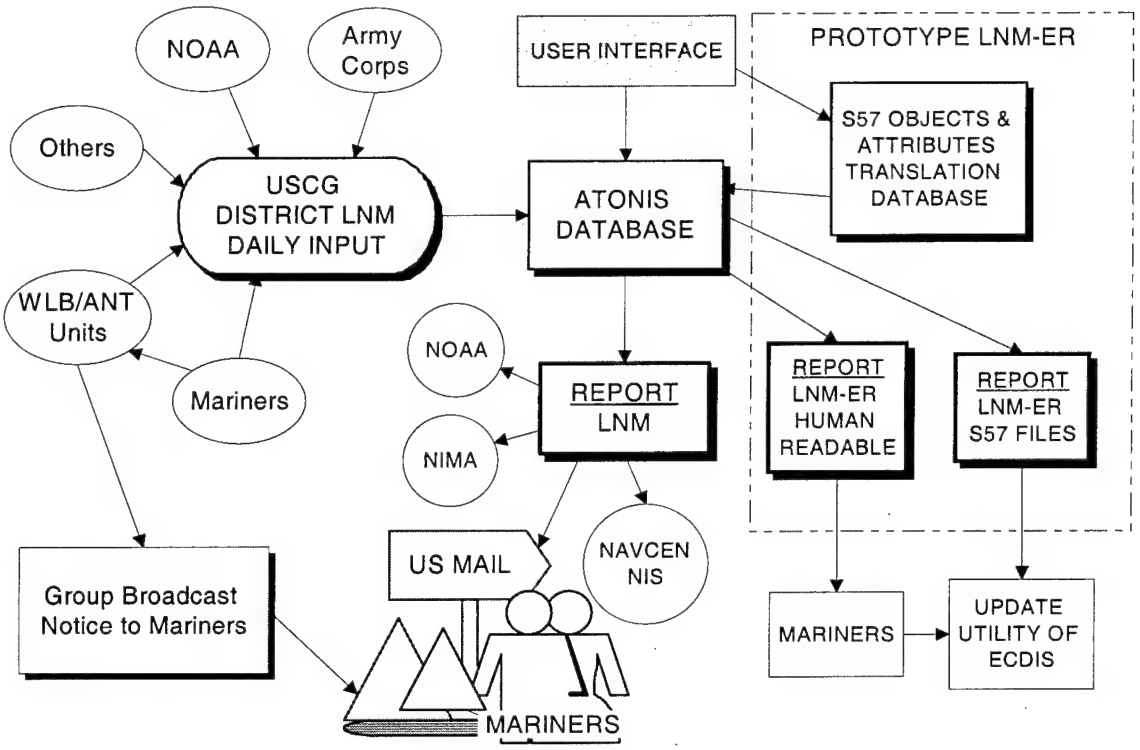

Figure 3-1 Existing LNM Process & Prototype Local Notice To Mariner-ECDIS Revision (LNM-ER) Design

APPENDIX C contains "THE FUNCTIONAL REQUIREMENTS FOR THE R&D CENTER'S LNM-ER PROTOTYPE DEVELOPMENT SOFTWARE" and APPENDIX D contains "THE DESCRIPTION OF THE PROCESS OF CREATING AN LNM-ER FROM ATONIS.""

3.2 RESULTS

The S57 objects and attributes database proved to be a very robust and complete structure for describing all types of hydrographic information. It was also determined that there are limitations in the structure of the ATONIS database and missing information required to create an LNM-ER. The following section describes several of the attributes not available in ATONIS and other examples of some required changes.

3.2.1 MISSING ATTRIBUTES

The following list is not exhaustive.

- Topmarks descriptions appear in the Light List and should be a separate object for ECDIS purposes. To provide a full image set to S57, this information must be in ATONIS.

- Cardinal buoys and beacons are not specified in ATONIS.
- Special purpose marks are attached to special purpose aids, but are not specified in ATONIS.
- Add a field for vertical length of aid (water level to tallest point of the aid).
- ATONIS charts table provides detail about charts. It is recommended minimum and maximum scale data be added to the charts table.
- Create a pick list in the chart correction log for the category **N/A**. This will help to standardize chart corrections for the paper publication and also make it possible to include this category into ECDIS updates.

3.2.2 CHANGE IN PRECISION AND UNITS OF POSITIONAL INFORMATION

ECDIS processes the location of a chart correction using degrees decimal. ATONIS maintains position information in degrees, minutes, and seconds. The precision of position location in ATONIS must be improved so that the errors are resolved when converting positional information to degrees decimal. Rounding errors could cause the ECDIS system to incorrectly position a chart correction.

3.2.3 ACCESS TO THE DATABASE OF ENC'S

Specific information describing each object found on a chart is contained in the ENC. In many cases, this is the only place this information can be found. It was determined that some of this specific information was necessary to produce an LNM-ER. ATONIS did not have this information. This indicates a need to have access to the database of ENCs in order to be able to retrieve this information. Suggestions on how this might be accomplished are discussed below.

3.3 SUMMARY

It is recommended that the USCG consider using the S57 structure to describe the hydrographic information contained in the ATONIS database. It proved to be a robust and complete structure for describing aids.

Fully compliant ENC updates are impossible to achieve from the present ATONIS database alone. Modifications to ATONIS will provide a more usable system, but it will still fall short in providing compliant ENC updates. The primary reason for this is the lack of access to the database of ENCs. In this country, NOAA is the responsible agency for producing ENC's. Ideally, NOAA would be in the best position to create updates to the ENCs since they have the database. USCG, however, has the information concerning the changes that NOAA needs, as well as, the responsibility for providing this information to the public. One possible option to this challenge would have the USCG produce S57 update data, less the information they do not have (i.e. data from the ENC) and pass this information to NOAA to fill in the gaps before USCG distributes the information. Another option would be to have NOAA provide the

USCG access to the database of ENCs to fill in the gaps before distributing the update. In either case, it is recommended that the USCG move towards the capability of producing chart corrections and ENC updates in the S57 format.

4. EXAMINATION OF THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) GUIDANCE ON UPDATING THE ENC - A TEST AND EVALUATION OF VARIOUS TOOLS AND METHODOLOGIES REQUIRED

This test and evaluation was designed to examine several issues underlying IHO S52 Appendix 1 - Guidance on Updating the ENC. These issues included:

- the format, application, verification, and logging of electronic chart updates;
- the display of colors, symbols, and highlighting of updates during route monitoring and;
- the feasibility of manually updating line and area objects.

The goal was to build on the broad understanding of ENC updating learned during the evaluation of the IMO Performance Standard for ECDIS and develop specific guidance that could be used by:

- maritime authorities to establish the necessary infrastructure for electronic chart updating;
- manufacturers to implement the necessary capability on the ECDIS to update the electronic charts and;
- mariners to have a safe and effective means for updating electronic charts.

This test and evaluation was also designed to provide the USCG with information, understanding, and some possible suggestions to help bridge the gap between present day USCG Local Notice to Mariners for paper charts and updates for electronic charts.

4.1 APPROACH

At this point in the project (October 1995), several factors influenced the direction of the research. NOAA had not produced any official S57 compliant ENCs, only a few prototypes in an old version of the S57 standard. Without S57 chart data, updating the ENC seemed to be a moot point (i.e. no charts, no updates). In the mean time, the use of electronic chart systems (ECSs) was on the rise in the U.S. and is continuing to be used by more and more mariners. These systems use proprietary electronic chart data, not official S57 ENCs which are created from national hydrographic office source data. Some of these data are in the S57 format (but are not official data) and some of the chart data are in other formats. The demand for USCG to provide electronic chart updates for these systems is also increasing. This aspect of updating an ECS brought with it a new set of requirements. Another factor was the timing of the latest release of S57 by IHO (beta edition 3 - March 1996; final edition 3 - November 1996). The beta version was released about 14 months after our development began on the prototype display system which was designed around version 2 of the S57 standard. Significant time and money would be needed to upgrade our system to be compatible with S57 edition 3. The third factor was the pressure from the IHO standards committees to complete the evaluation of the standards on updating the ENC by November 1996.

After weighing the factors mentioned previously, it was determined that the test and evaluation required four pieces:

- a test plan to insure that the most important issues in IHO S52, Appendix 1-Guidance on Updating the ENC, would be evaluated.

- a prototype display system to field test the updating methodologies, colors, and symbols using version 2 of S57. This is not the experimental ECDIS mentioned earlier in this report. This system was developed in-house.

- prototype electronic chart update (ECU) software that would draw the majority of its information, directly from the LNM rather than the ENC. In this way, field trial tests using actual updates could be performed. It would also help the USCG transition to S57 type electronic chart updates. This approach had an added advantage because the ECU would be formatted in such a way that both ECSs and ECDIS could make use of it.

- field trial test to gather data to assist in the examination of the IHO S52 standard and to determine the capabilities and limitations of the ECU to provide the necessary information to perform an update to an electronic chart.

4.1.1 FIELD TRIAL TEST PLAN

The test plan was divided into two parts. The primary reason for this was the need to compensate for the limitation of the prototype display system which could only handle IHO 57 version 2 data. This limited the testing to evaluating manual updating only, since the automatic updating portion of this version of the standard had proven to be too immature. Limited time and resources did not allow for the upgrade of the prototype display system to handle IHO S57 edition 3 data and the new more robust automatic updating specifications. For this reason, part 2 of the test plan was never completed. Table 4-1 summarizes the two parts of the test plan. The table is broken up into three areas, the version of the S57 standard implemented, the type of update to be performed and the format of the ENC update to be used.

Table 4-1 - Field Trial Testing Summary Table

	ECDIS Standards Implemented on Prototype Display System	**Type of Update to be Performed**	**Formats of ENC Updates to be Used**
Part 1	IHO S-57 *version 2* and Compatible IHO S-52 version	Manually by Mariner	Electronic Chart Update (**ECU**) as ASCII Text
Part 2	IHO S57 *edition 3* and Compatible IHO S-52 edition	Manually by Mariner and Automatically by prototype display system	Electronic Chart Update (**ECU**) as ASCII Text and ENC/ECDIS Updates as specified by IHO S-57 edition 3

The prototype software to produce the Electronic Chart Update (ECU) was developed at the R&D Center. The ECU is created by converting Section IV, Chart Corrections, of USCG Local Notice to Mariners (LNM), into a digital form. More details about the ECU are discussed later in this section of this report.

The goal of this testing was to collect data to support and resolve outstanding issues on chart updating. Each issue that was tested incorporated various options to determine the best solution. The options gave the mariner an opportunity to see and compare a variety of possibilities. For example, the issue surrounding the format of the update required investigation into three variables. Each of these variables were implemented on the prototype display system with two options.

Variable 1 - Attributes
Option 1) Only mandatory attributes are provided in update
Option 2) Attributes listed in update include mandatory (but not necessarily all) and non-mandatory attributes.

Variable 2 - Latitude/Longitude format
Positions are listed in:
Option 1) degrees minutes, decimal minutes
Option 2) degrees and decimal degrees

Variable 3 - S-57 terms in the ECU
Option 1) Update is described using S-57 code names followed by text
Option 2) Text equivalent only

Other issues such as the application of manual updates, verification and error checking, colours and symbols were implemented in much the same way. For more details on the issues and options tested see *APPENDIX E, TEST PLAN FOR ISSUES AND OPTIONS TESTED USING THE PROTOTYPE DISPLAY SYSTEM.* It contains two tables extracted from the Test Plan document. The first table is titled, "Summary of Issues and Options for Manual Updating - Part 1 & 2," and the second table is titled, "Summary of Issues and Options for Automatic Updating - Part 2."

The mariner was taken through a variety of scenarios designed to test the updating issues mentioned above. The prototype display system uses an interactive program to administer questions to the mariner at key times throughout the testing. The interactive program automatically records the responses and is designed to vary the order in which each option is introduced so that any learning effects or biases are reduced.

4.1.2 PROTOTYPE DISPLAY SYSTEM

The prototype display system is an engineering tool developed by the USCG R&D Center to examine the various electronic chart updating issues proposed by IHO S52 Appendix 1 - Guidance on Updating the ENC. Although the prototype display system is not a fully functional ECDIS (i.e. it does not include all the functionality required of an ECDIS), it has been designed and programmed to comply with the IHO specifications for reading and displaying ENCs. The system is comprised of a graphical user interface (GUI) upon which hydrographic objects (corresponding to S57 data) are displayed according to the IHO S52 Appendix 2 - Colours and Symbols Specifications. The objects are created with a software development kit using object oriented programming (i.e. Intellicorp's *PowerModel*) on an HP 750 workstation, in a UNIX environment. The run time version, in Windows NT, was ported to a Pentium Notebook computer for field trial testing. Figure 4-1 shows a sample screen capture of the prototype display system.

For more details on the prototype display system see *APPENDIX F - A DESCRIPTION OF THE USCG R&D CENTER'S IMPLEMENTATION OF THE IHO S57 AND S52 STANDARDS ON THE PROTOTYPE DISPLAY SYSTEM.* This appendix includes the *PROTOTYPE DISPLAY SYSTEM PROGRAM SPECIFICATIONS AND SOFTWARE DESIGN DOCUMENT (PS/SDD).* Please note that throughout several of the appendices, the term DX90 is used often. Recently, the international standards community decided to replace the term DX90 with the term S57. These appendices were completed prior to this change.

4.1.3 ELECTRONIC CHART UPDATE (ECU)

An Electronic Chart Update (ECU) was developed in order to perform field trial tests on electronic updating and to try to ease the transition from Local Notice to Mariners (LNM) type chart updates to S57 style chart updates. It is apparent that the current methods of chart correction collection, notification, and implementation will need to be modified in order to function properly in the digital world. The ECU is needed for two reasons: the limitations of the current LNM system and the lack of S57 compliant data. An additional benefit from the ECU is that ECSs can make use of it. The information needed to manually update an ECS is similar to that needed to update an ECDIS. In this way, when ENCs become available, and automatic updates will be possible with ECDIS, the ECU will continue to provide a service to ECS users.

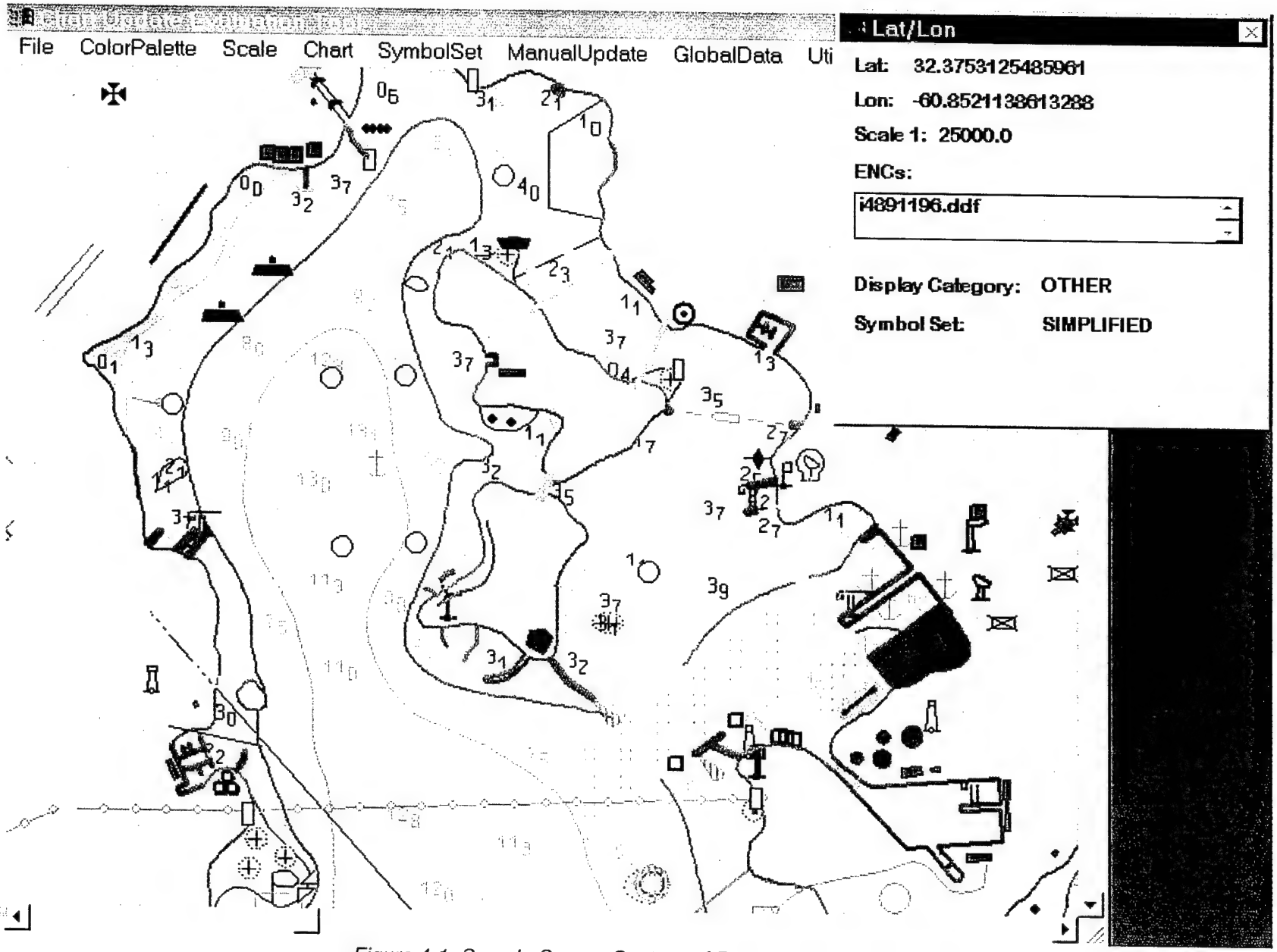

Figure 4-1 Sample Screen Capture of Prototype display system

4.1.3.1 Approach

The experience gained from the feasibility study led us to understand the requirements for generating an ECU. The first step was to identify and acquire all the information needed to create a complete electronic chart update that could be used by mariners with an ECDIS, an ECS or a paper chart. The following information sources were determined to contain various electronic chart updating information needed to create an ECU.

- S57 ENC data
- District ATONIS report (a complete set of all buoy data in an ASCII file created from an ATONIS query)
- Local Notice to Mariners (LNM)

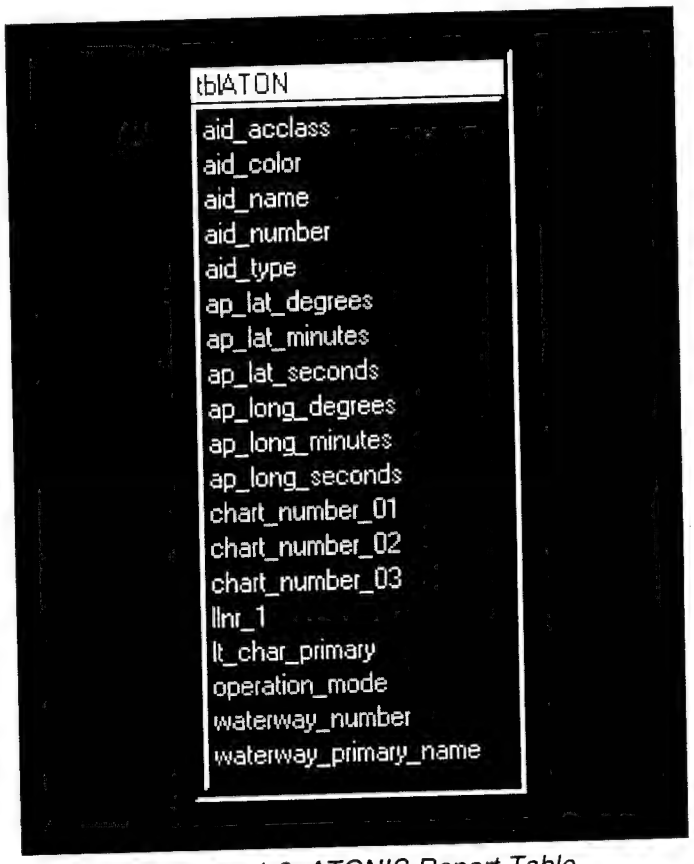

Figure 4-2 ATONIS Report Table

Plans to perform field trial tests with the ECU and the prototype display system required S57 ENC chart data. NOAA was unable to provide us with S57 Version 2 chart data, so we turned to the Canadian Hydrographic Service (CHS). We looked for a waterway that CHS had vectorized and contained U. S. aids to navigation.

One waterway which met this criteria was of the Detroit River Area. CG District 1 and CG District 9 provided us with an ATONIS report that could be used in our development (see Figure 4-2). D9 because of the Detroit area and D1 because we needed to be able to test our software to verify it worked with another district's ATONIS data and LNM reports. We downloaded D1 and D9 LNMs from NAVCEN's Navigation Information Service (NIS) using the Internet.

The data flow from the electronic chart sources of information to the creation of an ECU required several databases and parsers. The LNM report and the S57 standard needed to be translated or parsed into a form that was compatible with the structure developed for the ECU. Two parsers were needed to perform this translation, the LNM Parser and the S57 parser. A copy of the content and structure of the parsed S57 standard can be found in *APPENDIX 7 - OBJECTS ATTRIBUTES*. A database to house the parsed LNM (i.e. Chart Correction Schema A) and a database to store the parsed S57 data structure (i.e. S57 Version 2 Schema B) were required. The database schema was developed in Microsoft Access and is described in *APPENDIX 8 - SCHEMA*. We developed a proof-of-concept S57 converter. In its present form, it can convert the LNM instructions and details and send this information to the ECU database. Certain information regarding the charts affected by the update and sequence number for the update have to be entered manually before the ECU can be generated.

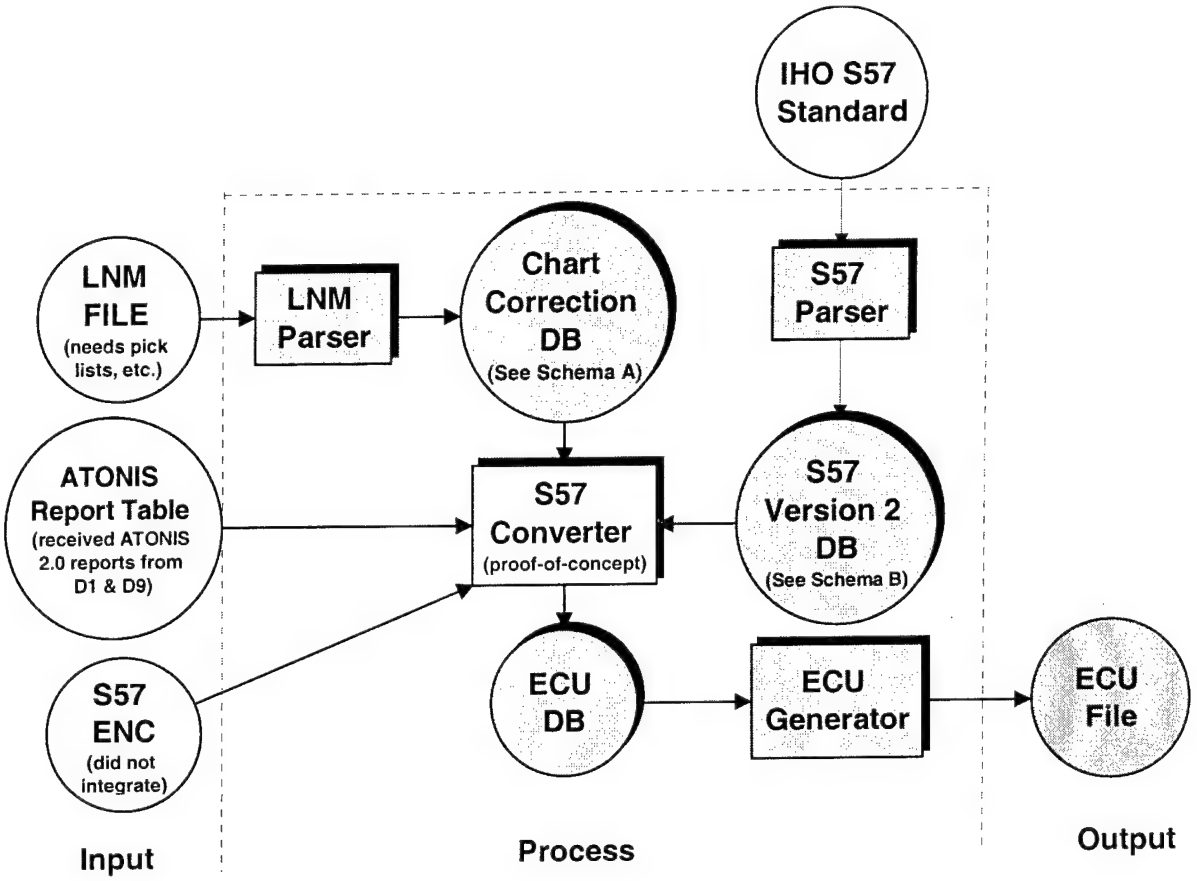

Figure 4-3 LNM to ECU Data Flow

Figure 4-3 shows the flow from the LNM file downloaded from the NIS and the ATONIS Report Table to the creation of the ECU. A description of the ECU file format and examples of four ECU actions (i.e. add, delete, change, and relocate) can be found in *APPENDIX 9.* The S57 ENC was never integrated with the S57 converter. Much of the information that was used from the ENC was manually incorporated into the S57 converter. This integration would need to be automated before the S57 converter could be fully functional.

4.1.4 FIELD TRIAL TEST

4.1.4.1 Equipment, Subjects, and Test Areas

During the period of September to November 1996, field trial testing of various aspects of electronic chart updating took place. USCG R&D Center personnel performed all of the field trial testing. Quartermasters and Officers of the Deck from both the USCGC BITTERSWEET and JUNIPER and Captains and Mates aboard four Canadian Steamship Lines (CSL) self-unloading and loading bulk carriers on the Great Lakes took part in the testing. These mariners were selected because each had between two and five year's experience using ECDIS under operational situations. In all, twenty-two mariners evaluated our implementation of

electronic chart updating on the prototype display system using the ECU. Each mariner took approximately two hours to complete the test. Table 4-2 describes the vessels, dates, locations and participants for the testing.

Table 4-2 - Summary of Participants

Vessels	Dates - 1996	Locations	Participants
USCGC BITTERSWEET	Tues, Sep 17	Station Woods Hole, MA	2 Bridge Officers 2 Quartermasters
USCGC JUNIPER	Thur, Sep 26 & Sat, Nov 23	Navy Base, Newport, RI	2 Bridge Officers 2 Quartermasters
M/V NATICOKE	Sat, Oct 05 to Mon, Oct 07	Clarkson, Canada at St. Lawrence Cement	Master, 1st, 2nd, and 3rd Mates
M/V DESMARAIS	Mon, Oct 07 to Wed, Oct 09	Hamilton, Canada at Stelco Steel Company to Baumanville to load cement, to Welland Canal, Lock 7.	Master, 1st, 2nd, and 3rd Mates
M/V MANITOULIN	Thur, Oct 10 to Fri, Oct 11	Welland Canal, Lock 7 to Hamilton, Canada, off-loaded cement, to Iroquois Lock, NY	Master, 2nd, and 3rd Mates
M/V FRONTENAC	Fri, Oct 11 to Sat, Oct 12	Iroquois Lock, NY, to Welland Canal, Lock 7	1st, 2nd, and 3rd Mates

4.1.4.2 Methodology

This testing was structured in such a way as to make it as simple as possible for the mariner to perform the test. Interactive instructions and questions were imbedded into the prototype display system, and data and response collection was automated. The questionnaire was designed to solicit information from the mariner about their impressions of electronic chart updating requirements prior to seeing and applying electronic chart updates. The mariner then had an opportunity to apply updates in a variety of ways and with a variety of views. This was done to help stimulate discussion and understanding of the implications of electronic updating. After applying and viewing the updates, the mariner was asked many of the same questions about his/her impressions of electronic updating that were asked before using the updating tool.

Figure 4-4 shows one of the menu structures used to manually add an object to the electronic chart using the information contained in the ECU. The combination of S52 and S57 gives the manufacturer a ready made data structure and pick list for updating. Using the menu from left to right, the mariner selects the object type, then the object, then the attribute and each value for the attributes. The mariners can then view the symbol in the traditional or simplified set of symbols. Information about the location and name of the object are requested in another window. When all the information about the update is filled out, the object appears

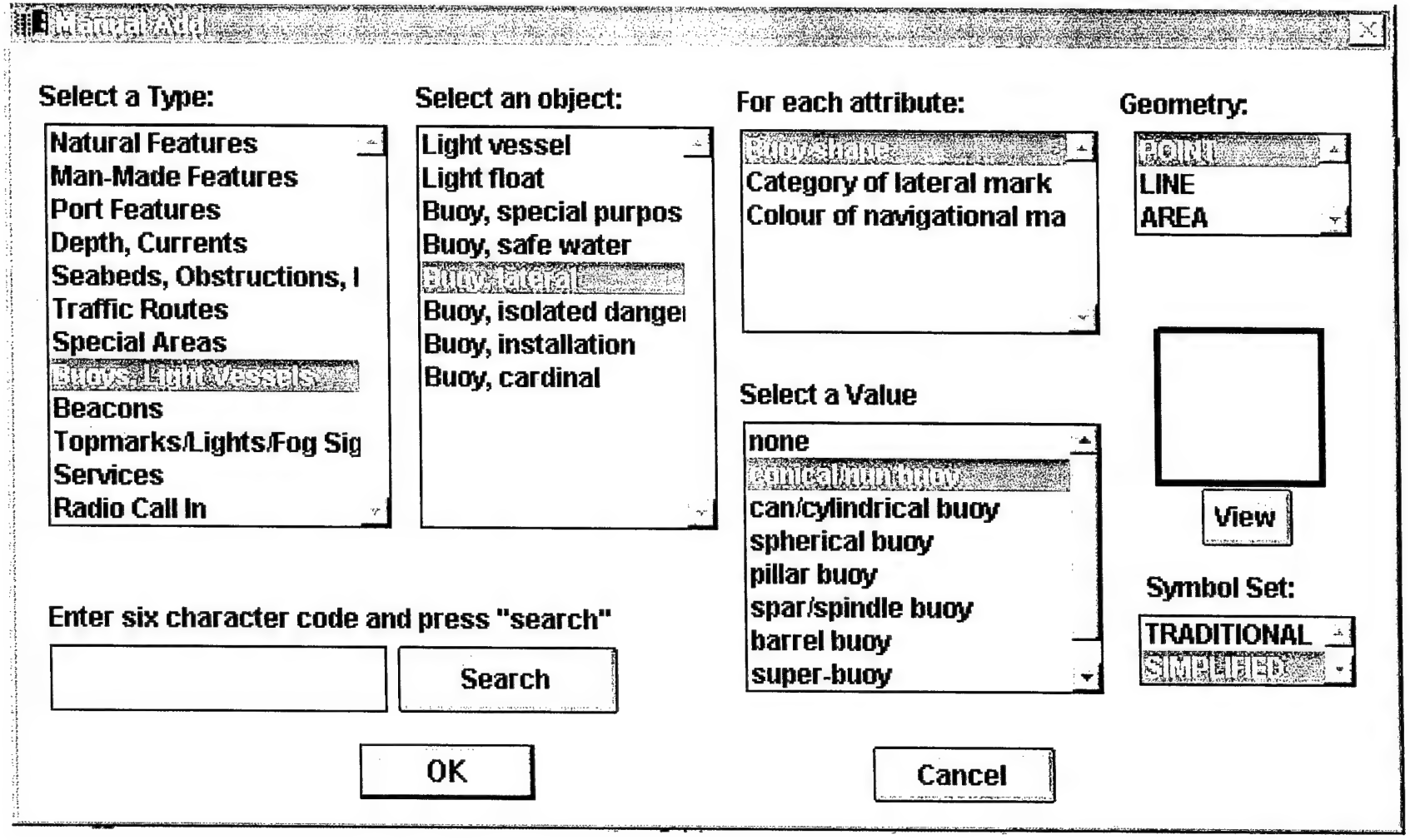

Figure 4-4 Menu for Manually Adding an Update on the Prototype Display System

on the electronic chart as specified by the mariner. The mariner has the opportunity to verify the formation visually on the screen or through any of the windows previously used. After the update is verified and accepted, it is logged into a permanent file.

The following three figures show the two primary views implemented on the prototype display system for manual updating. Figure 4-5 shows what we called View B. This is the view proposed by IHO prior to our testing. This same view is seen whether the system is in highlight mode or route monitoring. West Channel Outer Buoy 10 was added (buoy symbol is in orange), the radio call-in point was deleted (an orange slash is used for deleted objects), West Outer Buoy 2 was modified with an added light (a modified object has an orange slash through it and the new object is placed at a standard offset near the old object), and West Outer Buoy 9 was relocated (an orange slash is placed on the old object and an orange buoy is placed at the new position). Figure 4-6 and 4-7 show View A. In this case the route monitoring and highlight views are quite different. During route monitoring the added, deleted, modified and relocated symbols appear as standard chart information. In order to view the updates, the mariner selects a feature to "highlight updates" and orange circles and slashes appear. This view was created at the R&D Center to provide the mariner with alternatives to help solicit in-depth feedback. In both views and in both modes, any time the mariner cursor clicks on an object, detailed information appears regarding the object. Figure 4-8 gives an example of this. It also shows an update applied to an area (i.e. orange dotted line).

If the reader is interested in reading through the various instruments used during these sea trials, see *APPENDIX J.* The following lists these instruments:

- INSTRUCTIONS - for performing the test and operating the prototype display system (pages J-1 to J-9)
- DEFINITIONS/ACRONYMS - to define electronic chart updating terminology (pages J-11 to J-12)
- A COPY OF THE INTERACTIVE QUESTIONNAIRE IMBEDDED IN THE PROTOTYPE DISPLAY SYSTEM (pages J-13 to J-21)
- A COPY OF THE INTERACTIVE DIRECTIONS/COMMENTS IMBEDDED IN THE PROTOTYPE DISPLAY SYSTEM (pages J-23 to J-25)
- THE ACTUAL ECU USED - several variations of the ECU were used to test the effectiveness of different formats (Appendix J, starting at page J-27, output from ECU Generator)

4.2 RESULTS

4.2.1 THE FORMAT, APPLICATION, VERIFICATION, AND LOGGING OF ELECTRONIC CHART UPDATES

When it came to the format of the ECU, the mariners in general felt that they could deal with

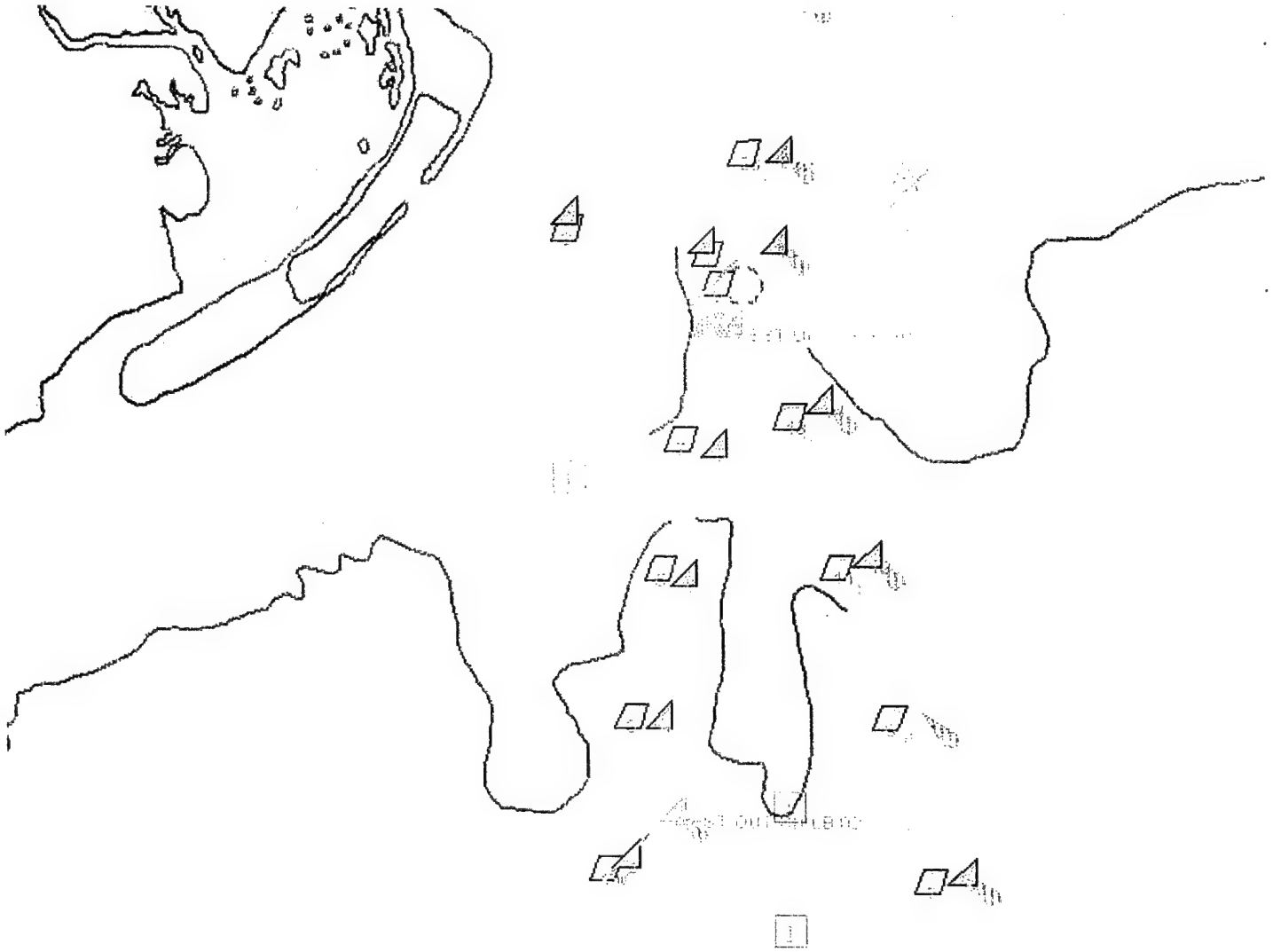

Figure 4-5 View B of Prototype Display System During Route Monitoring

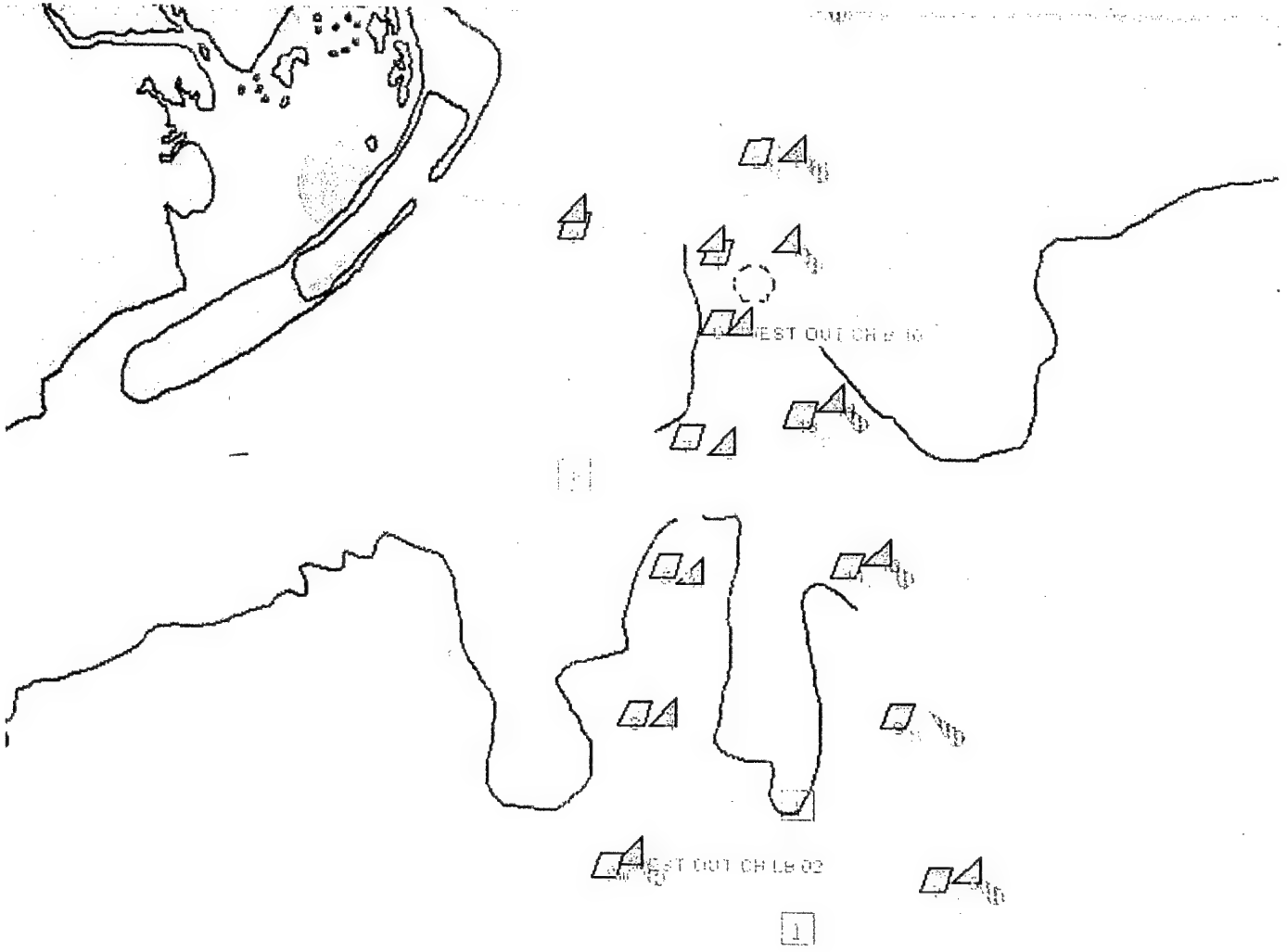

Figure 4-6 View A on the Prototype Display System During ***Route Monitoring***

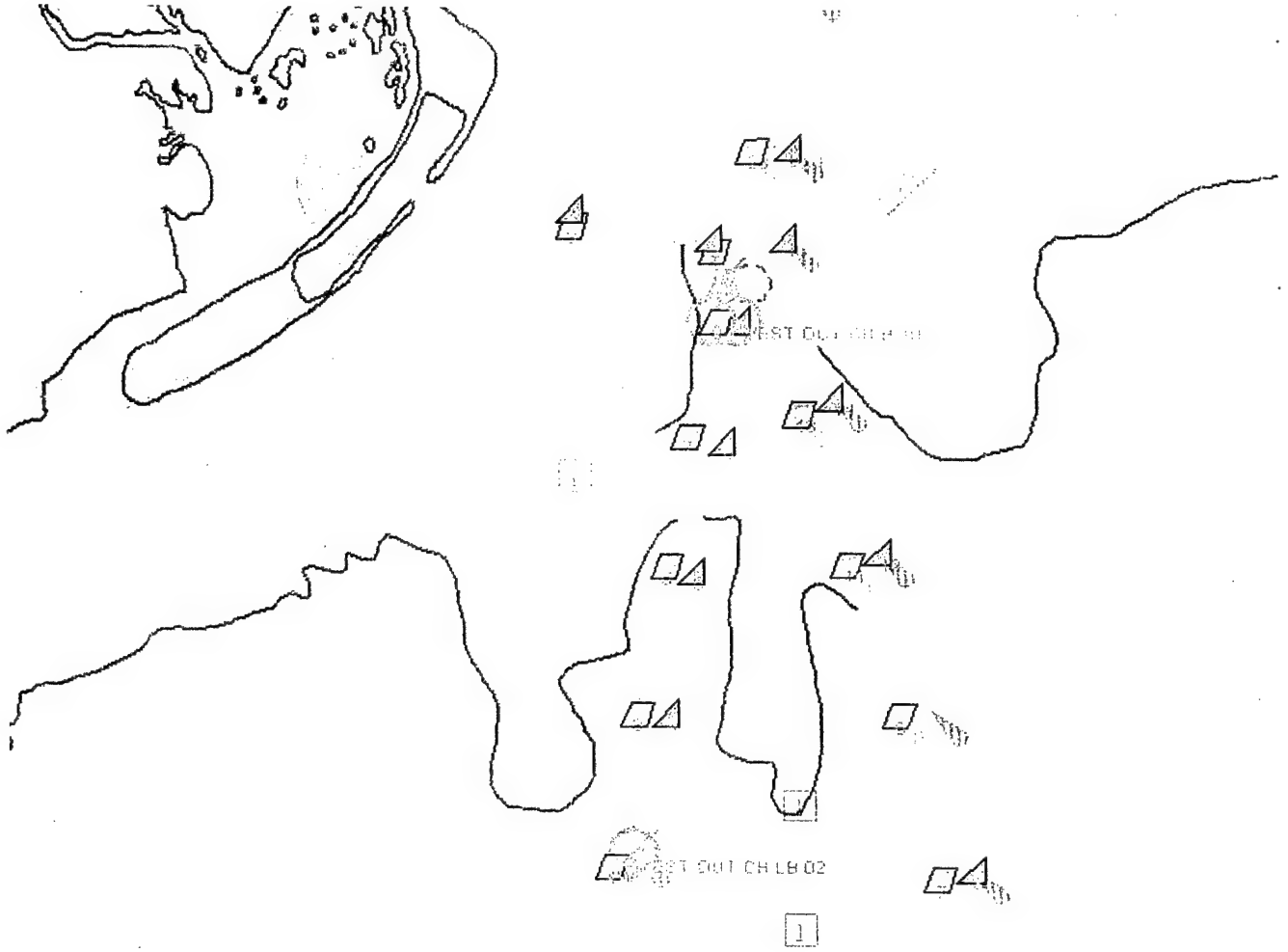

*Figure 4-7 View A of Prototype Display System in **Highlight Mode***

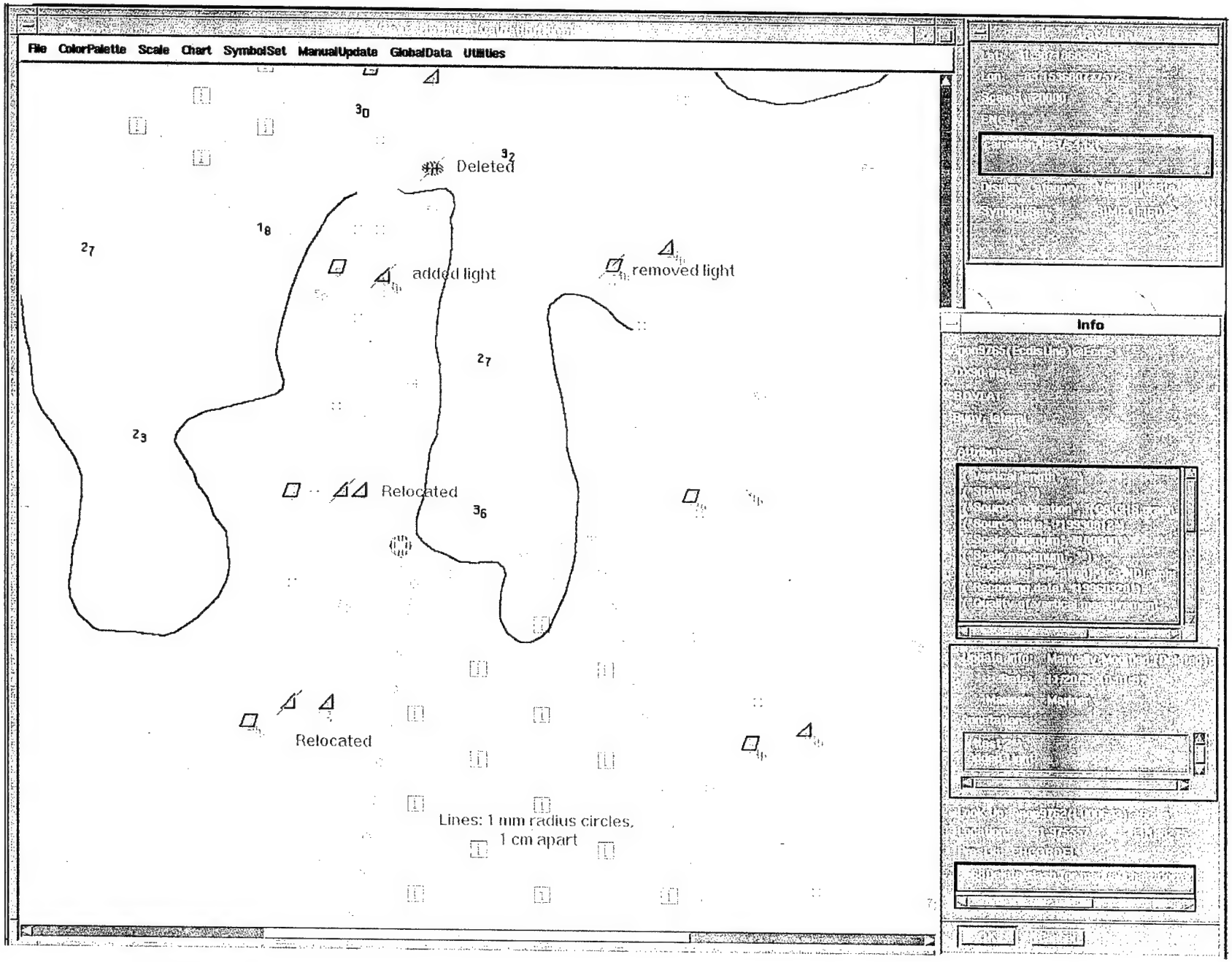

Figure 4-8 Example Screen Capture of an Information Box Describing the Light Added to a Lateral Buoy

any of the formats presented to them as long as it was consistent. They understood that the electronic chart was different from a paper chart and required a format different than the present LNM format. They also felt they would get use to the six letter codes from the S57 standard especially if the codes were published and could be looked up easily.

The application and verification of the updates took up the majority of the mariners time during the test. There are two possible procedures by which manual updates can be applied to the electronic chart:

- Overlay - in which the manual update is applied only graphically (i.e., there are no connections to the underlying attribute information, similar to raster data);

- Incorporated - in which the manual update is integrated with the chart information (i.e. vector data).

Fifty-nine percent (59%) of the mariners tested felt comfortable making changes directly to the chart (i.e. incorporated). When asked if manual updates should be an overlay, 81% either strongly disagreed or disagreed with the use of overlay. Verification of updates proved to be an interesting area of discussion. The mariners needed to enter their user name and password before entering the updating mode on the system. All the mariners tested felt that verification was necessary. How it should be implemented varied from mariner to mariner. Some preferred a graphical check, others preferred checking the information textually. They all agreed that the mariner should have the ability to remove an update that was applied. They understood that all actions performed by them were recorded permanently in a log under their user name and password.

4.2.2 THE DISPLAY OF COLOURS, SYMBOLS, AND HIGHLIGHTING OF UPDATES DURING ROUTE MONITORING

The questions of colour, symbology and highlighting were thoroughly reviewed and evaluated. The mariners had an opportunity to view applied updates in various ways. The following responses indicated the mariners' opinions of colour, symbology and highlighting. It is interesting to note in these questions that the opinions of the mariners changed after they had an opportunity to view the information.

- The standard states that "..Manual Updates should be distinguishable from the ENC information and its Official Updates, but not affect display legibility.." Which of the following best meets these requirements:

	Before	After
A) the object is displayed in standard colors and symbols, and can be highlighted on demand.	73%	**91%**
B) the object is at all times displayed in the colour orange.	27%	0%
C) other	0%	9%

- Which of the following methods of highlighting would be most effective to distinguish Manual Update information from the ENC and its Official Updates (automatic updates):

	Before	After
A) manually updated objects are displayed in orange at all times.	19%	11%
B) all updates are circled or slashed in orange only upon request.	14%	**47%**
C) information about the object is available by double-clicking on the object	19%	11%
D) choices b and c together.	38%	21%
E) other	10%	11%

4.2.3 THE FEASIBILITY OF MANUALLY UPDATING LINE AND AREA OBJECTS

This was one of the first times, if not the first time, manual updating of lines and areas on an electronic chart were performed by a mariner. The mariners pointed out that, in general, point objects are most often seen in LNMs. Line and area updates occurred less frequently. For this reason they felt that it was necessary to be able to perform these updates and understood that it would require more time to perform. The following responses were received after the mariner performed a simple line and area update.

- I found the implementation for Manual Updates of Lines I used today to be straightforward.

Response	Percent
Agree	58%
Strongly agree	42%

- I found the implementation for Manual Updates of Areas I used today to be straightforward.

Response	Percent
Agree	45%
Strongly agree	55%

After performing the updates and understanding the process, the majority of the mariners felt comfortable with the process as seen in the results of the following question.

- Manual Updates for lines and areas objects will sometimes result in large changes to the electronic chart. I am comfortable with this level of Mariner-controllable change.

	Before	After
Strongly Disagree	9%	
Disagree	14%	9%
Agree	45%	68%
Strongly Agree	32%	23%

APPENDIX K contains a *DETAILED ANALYSIS OF ALL QUESTIONNAIRE RESPONSES* for those interested in reading more about the mariners' feedback.

4.2.4 ELECTRONIC CHART UPDATES (ECU) USING CURRENT LOCAL NOTICE TO MARINERS (LNM)

4.2.4.1 Limitations of the Current (LNM)

The current LNM falls short of providing all the information needed to update ECDIS or ECS charts in a variety of ways.

- Insufficient location precision. In order for a ECDIS / GIS (Geographical Information System) to identify the exact object to be updated, the precise location of the object must be given. The current LNM records the location to tenths of a second. For example: 43°43'24.6"N 070°00'20.0"W. In order for an ECDIS system to be usable for navigation, position to thousands of a second is necessary. The Laptop Automated Aids Positioning System (LAAPS) and ATONIS have this precision, but it is not supported in LNM reports.

- Inadequate attribute definition. For an ECDIS system to be able to correctly modify an object, the object must have a unique identification. This is required for the ECDIS to resolve which object is being added or changed, especially if relationships exist between a variety of objects (i.e. buoys, lights, areas).

- Data format consistency. While the format of the chart correction in a LNM is easy for a human to read and distinguish, it is not that easy for a computer to read. Varying length fields, inconsistent spacing and lack of conformity on data entry all make for problems using the LNM as an electronic update.

4.2.4.2 The ECU Makes Use of the IHO S57 Standard

The lack of S57 data has resulted in the inability to implement ECDIS updating as required by the IMO and IHO ECDIS standards. In order to accomplish S57 compliant updating, complete ENC data for the area must be available. This was true with S57 Version 2 updating and even more so with S57 Edition 3 updating. S57 Edition 3 data allows the update to modify certain object attributes with repeating only a minimal set of information about the object being updated (an object identifier that exists only in the ENC, and is unique worldwide!). The ECU uses the objects and attributes given in the S57 model to implement updates. This will make it easier for an S57 compliant ECDIS to read the data, because it already "knows" about all of the objects and attributes. This will also make it easier for the mariner to manually enter updates by bridging the gap between the current LNM structure which the mariner must interpret, and the S57 objects and attributes which the ECDIS can interpret.

4.2.4.3 Inclusion of Electronic Chart Systems (ECSs) in Electronic Chart Updates

Complete S57 compliant updating will not be useful for ECSs unless the ECS uses S57 compliant data. Presently, most systems do not support the use of S57 data. In this case, the ECS will not have all the information contained in the ENC. As stated above, even when S57 data becomes available, the amount of data in the update is insufficient to update a paper chart or an ECS. The ECU will include all known information about the object, from the LNM, ATONIS, and the ENC.

5. CONCLUSIONS

5.1 ELECTRONIC CHART UPDATE (ECU)

The work on the feasibility study and the development of the ECU have led us to conclude that the IHO standard S57 can provide the Coast Guard with a ready made structure for defining and building an aids to navigation database. This database would support Local Notice to Mariners (LNM) for paper chart users and electronic chart users. This standard is an international standard and would provide compatibility and understanding world wide. This structure also works well for providing aids to navigation information to other agencies, in particular National Oceanic and Atmospheric Administration (NOAA) and the National Imagery and Mapping Agency (NIMA) because the structure of this standard was specifically designed to transfer digital hydrographic data. The function, content, and format of the ECU proved to be an acceptable replacement for the LNM. Present day paper Local Notice to Mariners require the mariner to interpret the information. The ECU provides the information in a much more structured way so that even a computer can make use of it directly while maintaining a human readable form.

Figure 5-1 shows a conceptual diagram of what the USCG aids to navigation database might look like if IHO S57 is used. S57 aids to navigation tables would provide the description of the aids (i.e. government floating aid, red, light characteristics, etc.). This is the information required for chart corrections. Extensions tables would be needed to incorporate all the information the Coast Guard uses for these aids (i.e. chain length, battery life, sinker size, inspection dates, etc. The extensions block would be relatively simple to design because the structure for this information would follow the S57 standard.

Similar types of extensions to S57 are being created by other groups around the world. One such example is the S57 extensions for ice objects. The chart correction tables would be similar to the forms and reports in Aids to Navigation Information System (ATONIS) used to create LNMs. These tables are the repository for outputs from LAAPS and other chart correction information required to create an update. These chart correction tables would be able to produce ECU files which are machine readable and LNM files which are human readable from one request. Mariners can also query the tables (i.e. through the Aids to Navigation Database) to find specific information they need. Another benefit from such a database would be the improved potential for Buoy Tenders to access the database to update it and to perform quality checks on the updates by applying them directly to their onboard ECDIS.

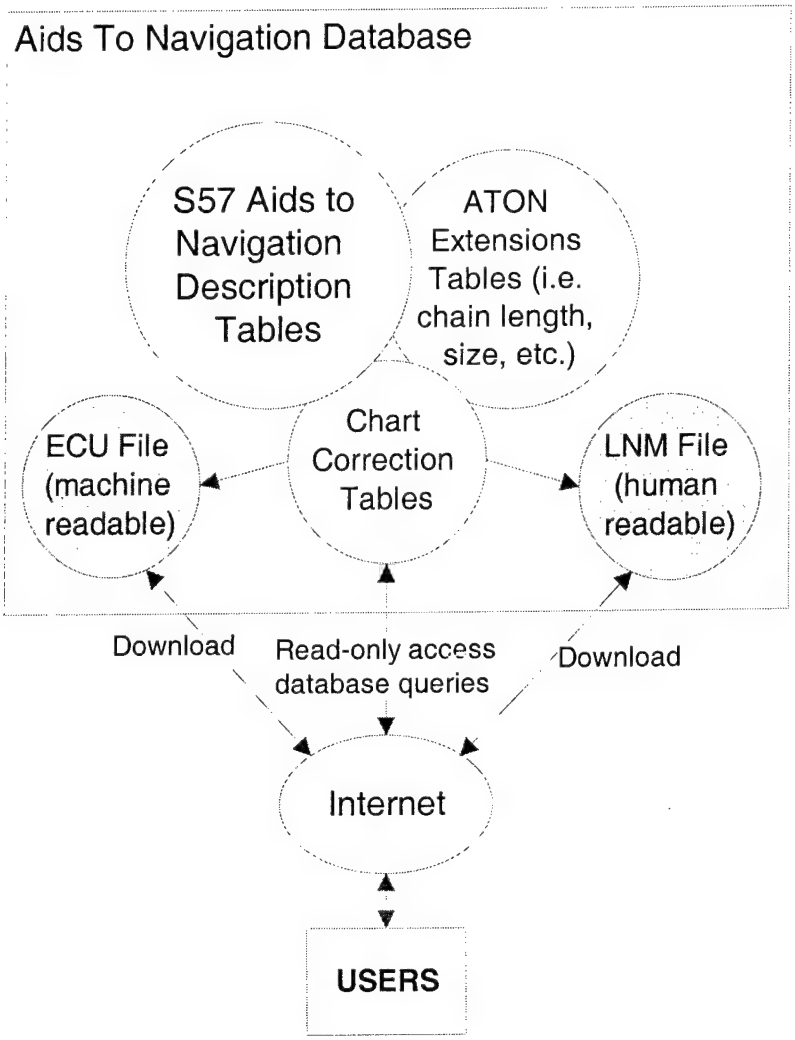

Figure 5-1 Conceptual USCG Aids to Navigation Database System

Ultimately updates to the Electronic Navigational Chart (ENC) will primarily be done automatically. ECDIS was designed with this capability in mind. The lack of ENCs today, requires that manual updating or some semi-automatic type of updating be available to mariners to update their electronic charts. This need to manually update electronic charts will steadily increase as more and more mariners use ECSs to complement their portfolios of paper charts. Only when official ENCs are available, will the need to manually update the electronic chart diminish. At that time automatic updates will be available. The use of S57 in a Coast Guard aid to navigation database system would provide update information in a form NOAA, NIMA, and mariners can use now, and after ENCs become available.

5.2 IHO UPDATING STANDARDS

The best colors, symbols, and highlighting capability for manual updates during route monitoring were determined. A R&D Center proposal was provided to the IHO working group on ENC updating, summarizing these results. These findings were incorporated into the IHO S52 standard for updating the ENC. Resolving the issues of symbology and functionality of manual updates was an important goal of this testing. Figure 5-2 shows the resulting symbology. The manually updated point object has an identifier, a stick with a circle in orange, indicating that the point object was updated or an orange slash indicating it was deleted. The symbol itself is in IHO standard colors and symbols. Small orange circles on lines indicate changes to the line or area represented by the line. Note again that the symbology and colour of the line is in standard colors.

It is important to note that one of the mariners that took part in this testing made the recommendation to use an "asterisk" near the object that was updated to indicate a change. It was this recommendation that led to the final specification (i.e. line with an orange circle, manual update identification). Seeing and using the prototype display system made a difference in how well the mariner was able to understand and apply new concepts concerning electronic chart updating. There was also a noticeable shift in the responses to certain before and after questions. Using the tool made a positive difference in the mariners' understanding of the issues and interpretation of the requirements

From the sea trial testing, it was determined that an electronic chart must have an uncluttered but distinguishable display for viewing updates. A drawing tool which gives the mariner the capability to add information to the display is considered an overlay (i.e. raster image). An overlay has limited value to the mariner because the information cannot be queried easily and may cause excessive clutter. Recommendations to IHO to use vector based manual updates which are similar in capability to regular ENC data, were adopted.

This research resulted in the use of a manual update identification (i.e. line with an orange circle) which was also recommended to IHO for adoption in the standards. This has significantly helped the updating capability of ECDIS by providing a mechanism for adding and integrating changes to the ENC. The design of this mechanism is such that it can be extended to incorporate other information added to the ENC, not just chart corrections. This is important, because as ECDIS matures, more and more navigational type of information will need to be integrated. Such information as weather, tides, currents, and information from Automated Identification Systems (AIS) and Vessel Traffic Services (VTS) are all being looked at for integration. The standard now provides a mechanism for the identifier to be used. By changing the colour of the identifier (i.e. line with a circle) the source of the information can be readily determined. This has resulted in a very robust standard.

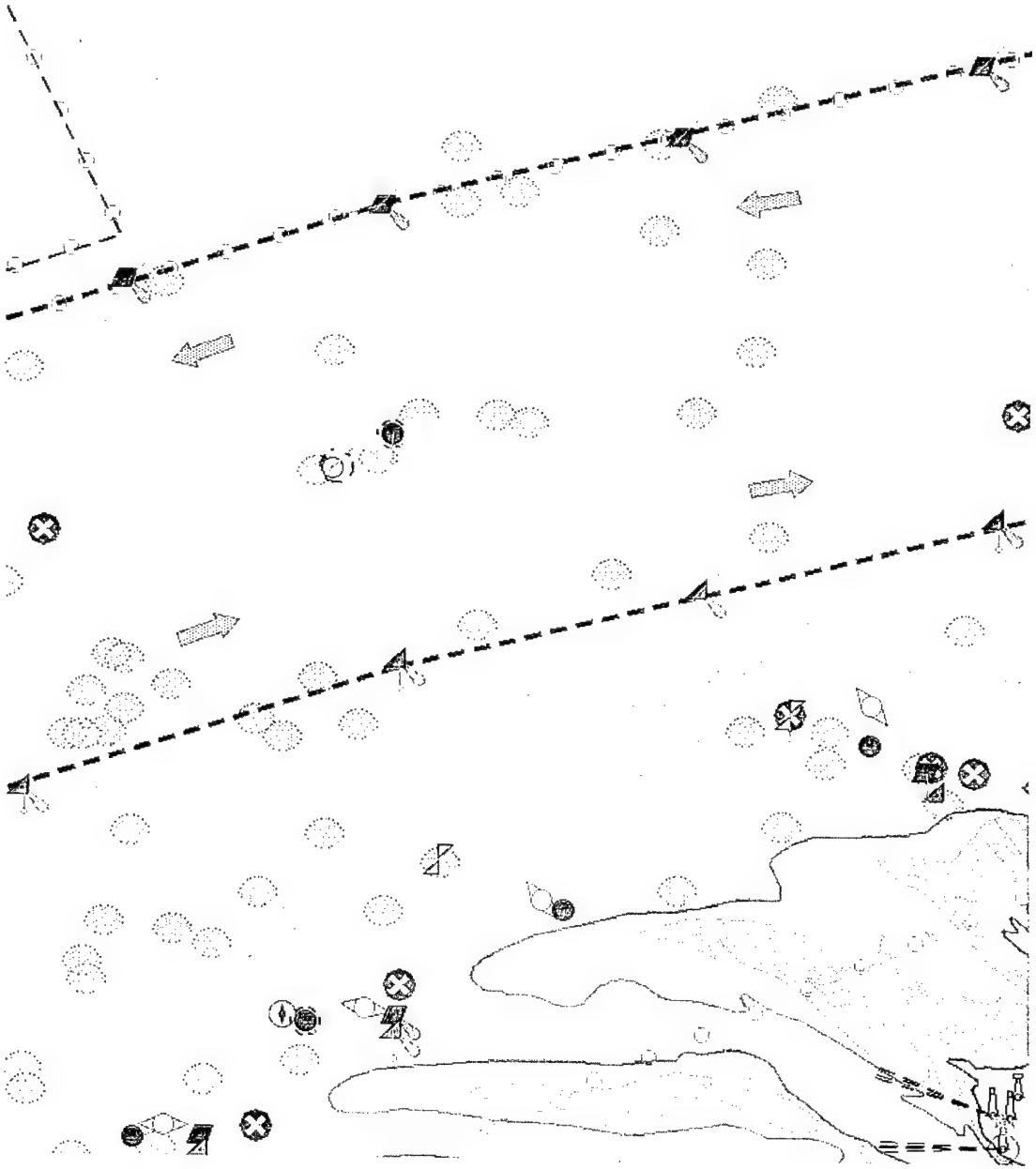

Figure 5-2 Symbology for Manual Updating Adopted by IHO

6. REFERENCES

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APPENDIX A - DESCRIPTION OF CHART UPDATE DATA, GRAPHICS, AND PERFORMANCE MEASURES (October 1994)

Chart Update Data

Update information is generally categorized by function and by content. There are five types of functions possible with paper chart corrections; add, delete, change, relocate, and substitute. The content of update information can be described in three feature classes: point, line, or area. Since the largest number of chart corrections are for point data (i.e. aids to navigation, point soundings, etc.) and since point data is the simplest content class of updates, only point data was implemented and tested.

Automatic update messages were transmitted in the IHO S57 format. In this format the update functions for "relocate and substitute" appeared as a "delete then add". This leaves only three types of functions (i.e., add, delete, and change/modify) for automatic ENC update messages. These updates were received on diskette from NOAA, and downloaded from the USCG Navigation Information Bulletin Board Service (BBS), using a cellular telephone and modem.

Manual updates were received on paper from present day paper chart Local Notice to Mariners (LNM) and downloaded as ASCII text files from the Navigation Information BBS. In this case four types of functions were available; add, delete, modify/change, and move/relocate.

Graphics

Manual Updates were designed to be graphically distinguishable from ENC data and automatic updates. Their graphic treatment was intended to resemble the penciled notations of LNMs on paper charts. After coordination with the IHO Colours and Symbols Working Group, the color orange was chosen for manual updates. Figure A.1 shows examples of the test symbols used for manual updates during these sea trials. The add symbol (e.g. wreck), the delete symbol (circle with a line through it), the move symbol (arrow with circle) and the modify symbol (circle with dotted pattern) are all in orange.

Automatic Updates appear as regular ENC data. The user can request that automatic updates be highlighted since a given date (user types in date). The highlight test symbol used for these sea trials for a point feature (S57 updates) was an orange circle. (See Figure A.2 for examples).

Figure A.1 - Test Symbols for Manual Updates

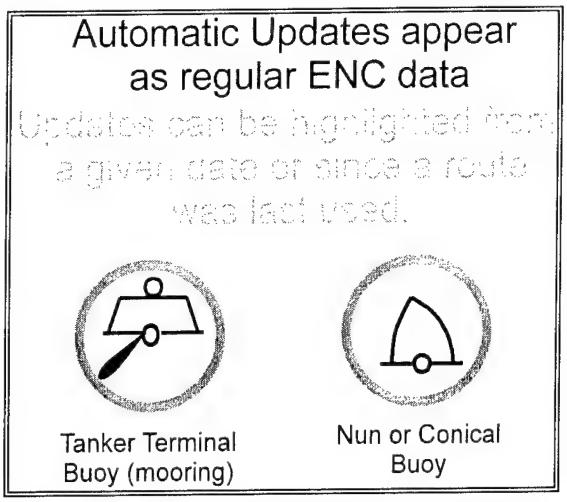

Figure A.2 - Test Symbols for Automatic Updates

It is important to note that the manual updating symbology and automatic highlighting symbol were created specifically for this test. IHO S52, "Provisional Specifications for Chart Content and Display of ECDIS" [IHO S52, 1993], did not address updating symbology. In 1994, the working group of IHO S52 Appendix 2 "Provisional Colours and Symbols Specification for ECDIS" [IHO S52, 1993] was tasked with developing updating symbology. Symbols used during this test and the responses received from the mariners were used as the foundation for this working groups effort on developing updating symbology.

Performance Measures

In order to measure the adequacy of the updating section of the IMO Draft Performance Standard each test subject was immersed in updating issues. First, the mariner answered a pre-questionnaire which asked about general background information and personal experience with updating paper charts. Next, the mariner was introduced to the sea trial test plan (Gonin, et al, 1994), objectives of the experiment, and procedures. Each mariner was then trained on specific chart updating features of the Testbed ECDIS. A debriefing-questionnaire was filled out. Finally, a post-sea trial questionnaire was completed. Approximately five hours was spent with each mariner.

APPENDIX B - DESCRIPTION OF ATONIS (November 1994)

ATONIS BACKGROUND

The Aids to Navigation Information System (ATONIS) is a software application that helps provide management for the U. S. Coast Guard's aids to navigation. It stores information on federal and private aids, chart and chart boundaries, chart corrections, and aid discrepancies. It also helps produce required publications such as LNM. Figure B.1 shows a simple flow for the existing USCG LNM process. NOAA, The Army Corps of Engineers, mariners, WLB/ANT Units, and others provide information to USCG Districts. The districts and NOAA verify the information. The districts then input the information into the ATONIS database, and produce a LNM Report once a week. This reports is provided to NOAA, NIMA, and NAVCEN electronically and to mariners on paper. Mariners can also download the LNM from the USCG NIS.

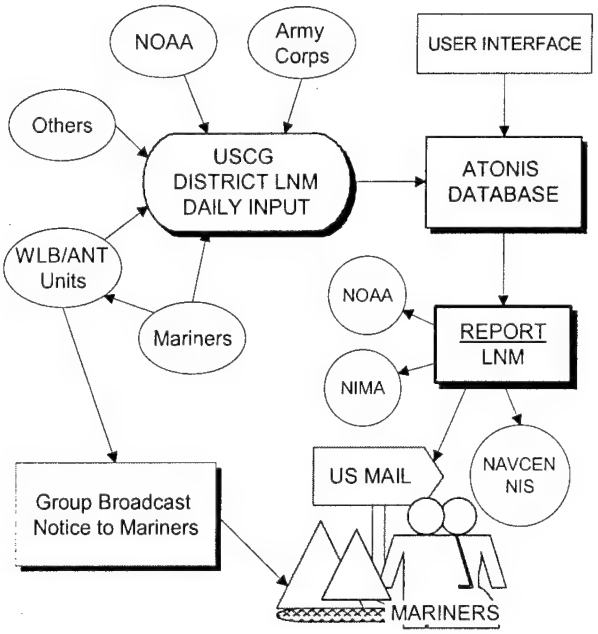

Figure B.1 - Simple Flow of Existing LNM Process

LNM section IV[1] ("Chart Corrections") is a standardized ATONIS report that contains information affecting chart changes. Examples are: additions; deletions; changes; substitutions; and relocation for aids to navigation. Non-aid information such as wrecks, hazards, soundings, etc. are listed as well. Paper chart numbers affected by these changes are also provided.

ATONIS 2.0 development was completed in September of 1994. It is written in Progress7 a 4th generation language (4GL). There are two distinct versions of ATONIS 2.0, one for districts and one for units, each is designed to support tasks specific to the intended user. Certain tables are designed to meet district requirements, such as chart corrections, and discrepancies. Other tables are in both data dictionaries (i.e. district and unit) where each user has access to certain fields in the tables. In this way information can be easily shared and updated. Canned reports, specific to a unit or district are produced and can be output to screen, hard copy or file. Figure B.2 describes the information flow and exchange of ATONIS information in more detail.

[1] Refer to Chapter 13 of the Aids to Navigation Manual (Comdtinst M16500.7).

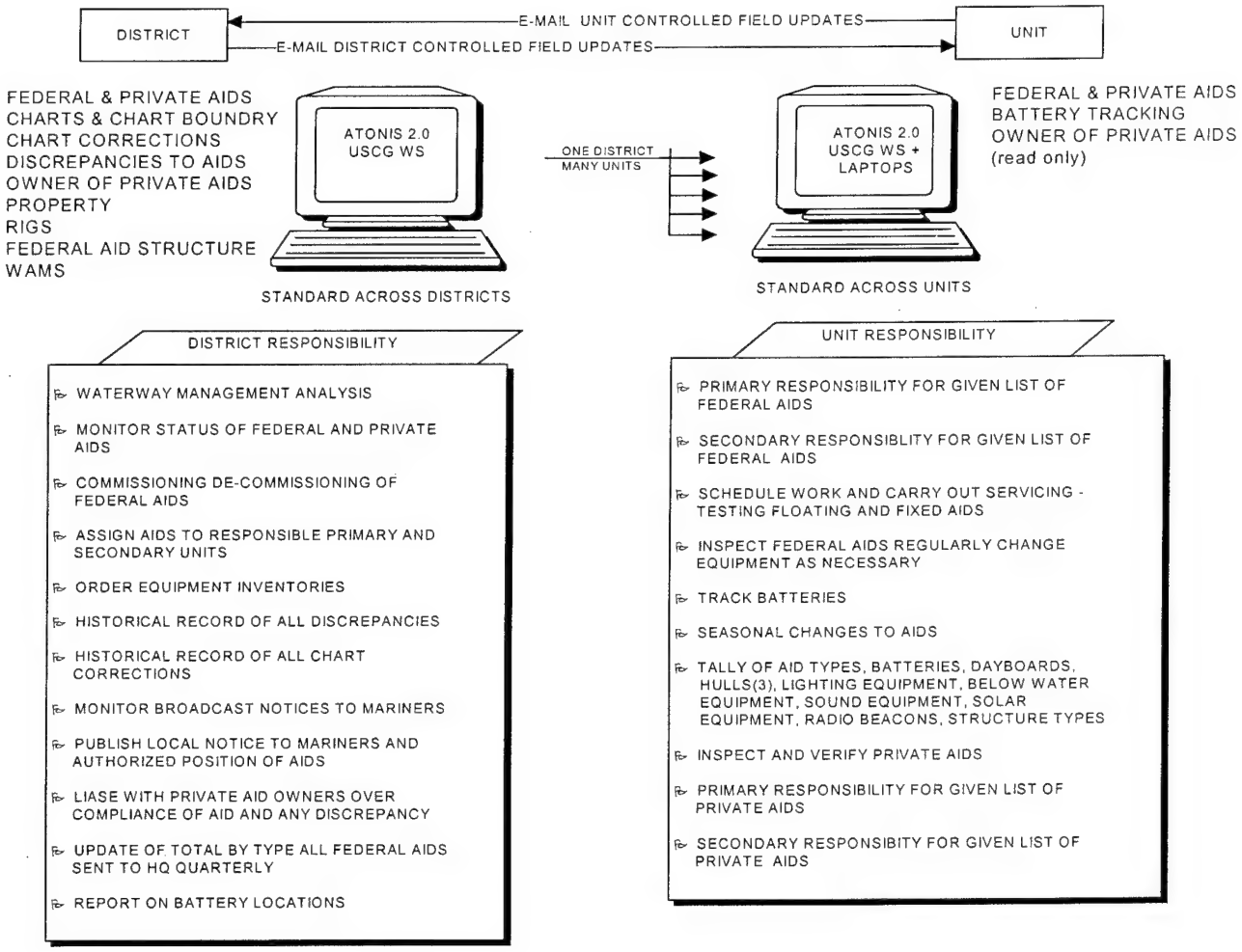

Figure B.2 - ATONIS 2.0

ATONIS DATABASE

In the ATONIS database, there are three categories of information: federal aids, private aids, and non-aids (i.e. soundings, wrecks, anchorage areas, etc.). The information describing these aids and non-aids is represented in a database developed in PROGRESS.

APPENDIX C - FUNCTIONAL REQUIREMENTS OF LNM-ER (January 1995)

1 GENERAL INFORMATION

1.1 Project Summary

The United States Coast Guard is required by federal law to publish and broadcast information about changes or hazards in navigable waters of the United States and its territories. This information is normally disseminated in a weekly publication known as Local Notice to Mariners (LNM) and in daily broadcasts known as Broadcast Notice to Mariners (BNM).

Mariners typically update paper charts by reading the LNM and annotating their charts accordingly. With the advent of ECDIS and the development of electronic navigational charts (ENCs) a new process is needed to support electronic chart updating. Such a system must be automated and error-proof.

The purpose of this effort is to investigate the possibility of using ATONIS to support ENC updating. This functional requirements document describes the requirements and approach to determine the feasibility of ATONIS to support ENC updating.

1.2 Project Environment

The feasibility study and prototype application will be completed at the USCG Research and Development Center located in Groton, Connecticut. When completed, the work will satisfy the requirements of task 1 of project element 2720.2.2, Electronic Navigational Chart. This project is sponsored by the Office of Navigation.

All work will be developed using the Coast Guard Standard Workstation (CGSW), IBM compatible computers, and workstations. Target user of a system like this will be the Coast Guard, National Ocean Service (NOS), and other government agencies and mariners operating ENCs.

1.3 Project References

The following references apply to this project:

- Project Master Plan 2720 Integrated Navigation Systems
- Project Element Sheet 2720.2.2
- COMDINST M16500.7. Aids to Navigation Manual - Administrator
- COMDINST M16500.3A. Aids to Navigation Manual - Technical
- FIPS PUB 38 Guidelines for Documentation of Computer Programs and Automated Data Systems

2 OVERVIEW

2.1 Background

The Aids to Navigation Information System (ATONIS) is a database that helps provide management of the Coast Guard's aids to navigation. It includes information on federal and private aids, charts, chart corrections, and aid discrepancies. It also produces standard reports such as the LNM.

LNM section IV[1] ("Chart Corrections") contains information that affect chart changes or corrections. Examples of corrections are additions, deletions, changes, substitutions, and relocations. Information about wrecks, hazards, and soundings are listed as additions.

LNM reports like chart corrections need to be compatible with ENCs. Additionally a method for making chart correction files available to ENC users must be recommended. An electronic bulletin board may be one option.

2.2 Objectives

Determine the feasibility of using ATONIS to support ENC updating. Appendix A demonstrates a possible flow between ATONIS, an object and attribute database, and eventual output to DX-90 and ASCII files. The files will support ENC utilities for updating.

2.3 Existing Methods and Procedures

NOS is currently responsible for producing and distributing navigational charts. Nearly all charts are color coded printed copies. Updates are accomplished by mariners or quartermasters annotating the charts in pen or pencil. The Coast Guard provides update information by mailing the LNM to them.

2.4 Proposed Methods and Procedures

Provide update files from ATONIS chart correction information in IHO S-57/DX-90 format. Use the files to update ENCs.

2.5 Summary of Improvements

ENCs cannot effectively be approved for use unless they can easily be updated. By providing a means to update ENCs automatically a major hurdle to implementing ENCs will be cleared. It is anticipated the use of ENCs will greatly enhance safe transit of waterways.

---

[1]Refer to Chapter 13 of the Aids to Navigation Manual (Comdtinst M16500.7).

2.6 Summary of Potential Project Impacts

If the project is successful some future impacts for the Coast Guard may be:

- No specialized equipment will be needed. The system will operate on the CGWS and it's bundled software.
- No major organizational changes will be needed. Districts will still be responsible for chart corrections in their major area of operation.
- No new operational requirements. Districts will generate update files as easily as they do now for hardcopy LNM. Most likely they will do both.
- A new USCG/NOS relationship will need to be developed.
- New policy will need to be enacted. New policy will be required to insure integrity of data and public access to the files.

2.7 Cost Considerations

Cost considerations are not a requirement for this phase of project element # 2720.2.2. Additional funds will be required to undertake prototype testing.

2.8 Resource Requirements

The following resources will be required to undertake the feasibility study:

- ATONIS 2.0 database, application source code, and test data.
- CGSW, MS-DOS®, and professional workstation computers.
- Software.
- Cables.
- Telephone / Modem.
- Printer.

3 REQUIREMENTS

3.1 System Functions

The prototype system shall have the following capabilities:

- CREATE read only chart correction files in International Hydrographic Organization (IHO) S-57/DX-90 compatible format. Software should be integrated into existing ATONIS 2.0 application. Operation should be limited to selecting options from menu(s).

- UPDATE ENC by processing file to update local DX-90 chart database.

- TRANSFER data (TBD). Update files should be accessible via an electronic bulletin board. Software and technology to accomplish a bulletin board design are readily available. An actual demonstration may be beyond the scope of this project.

- SECURITY of data (TBD). Security issues may be beyond the scope of this project.

3.2 System Source Code

All code will conform to COMDINST 5230.45.

Prototype source code will be written in PROGRESS® 4GL (version 6.2) and execute in the PROGRESS® RDBMS environment available under the CGWS bundled software package. All programs will have a header block with relevant information about the file. An example is shown below.

```
/*------------------------------ ATONIS 2.0 ENC------------------------------*/
/*  PURPOSE     :   OUTPUTS IHO S-57/DX-90 DATA FROM A LIBRARY                */
/*  NAME        :   enc_file.p                                                */
/*  CODED       :   J.Bagwell   10-94                                         */
/*  CALLED BY   :   encmen1.p   encmen2.p                                     */
/*  CALLS       :   NONE                                                      */
/*  INCLUDES    :   enclib99.i                                                */
/*  NOTES       :   All important notes.                                      */
/*----------------------------------------------------------------------------*/
```

Standard CGSW operating system (CTOS®) will be used.

The executable prototype system will integrate into existing ATONIS user interfaces. It must have the same "look and feel" as ATONIS, employing menu frames with option layouts identical to ATONIS.

3.3 Performance

System performance is not a requirement of project element #2720.2.2

3.4 Inputs-Outputs

Inputs will be limited to menu selections and possibly user answers to prompts. The inputs will fashion a response by the prototype module to search appropriate ATONIS data tables, select records and/or fields, and create reports and the DX-90 update files. The software will be required to manage and control memory and hard disk input/output. Work files may be required.

Inputs and outputs on the ENC cannot be controlled or determined by this project. Prototype demonstrations are possible.

Standard ASCII character output is required. Naming conventions for the output files must be determined. Filenames should be compatible across platforms. For example, filename.ext, is compatible with DOS®, CTOS®, and UNIX®.

Each update will have a catalog file, data description file, and feature file. The file set will be fully IHO S-57 DX-90 compatible. In addition there will be a readable report describing the update files.

3.4.1 Report List

The following shows the required reports:

- ENC Correction Review Report. A review of all fields used to produce the DX-90 files (human readable text format), see appendix A.

- ENC Correction Update Report (3 files: Catalog, Description, and Feature). DX-90 format.

The following figure is an example extract of a feature file. Not shown are examples of catalog or description files. They are similar in appearance.

```
008793L   0600155
330400001080000001036108OBID068144ATTF047212OBPT051259SEGT0
43310ATTS044353SG2D050397SG3D055447ARCC055502AR2D055557EL2D
069612CT2D043681▲0000;&I2190000.001▼0001OBIDOBIDATTFOBIDOBP
T0001SEGTSEGTATTSSEGTSG2DSEGTSG3DSEGTARCCARCCAR2DARCCEL2DAR
CCCT2D▲0100;&Record Identifier▼rcid▼(I(5))▲1600;&Object
Identifier▼MODN!RCID!FTYP!FCMP!OBJL▼(2A(5),2A(1),A(6))▲2000
;&Feature Attribute▼*ATTL!ATTV▼(A(6),A(!))▲2000;&Object
Pointer▼*NAME!ORNT!USAG▼(A(10),2A(1))▲1600;&Segment
Identifier▼MODN!RCID▼(2A(5))▲2000;&Segment
Attributes▼*ATTL!ATTV▼(2A(!))▲2200;&Segment Coordinates
(2D)▼*LATT!LONG▼(2R(!))▲2200;&Segment Coordinates
(3D)▼*LATT!LONG!DEPT▼(3R(!))▲1600;&Arc/Curve
Definition▼ATYP!SURF!ORDR▼(2A(1),I(1))▲2600;&Arc
Coordinates▼STPT!CTPT!ENPT*LATT!LONG▼(2R(!))▲2600;&Ellipse
Coordinates▼STPT!CTPT!ENPT!CDPM!CDPR*LATT!LONG▼(2R(!))▲2200
;&Curve Coordinates▼*LATT!LONG▼(2R(!))▲00236 D     00065
330400010060000BID019006ATTF133025OBPT013158▲
1▲FE_AA00056PSBOYLAT▲BOYSHP1!COLMAR3!OBJNAM4!RECDAT07-MAR-1
992!RECINDNOS,digi!SCAMAX20000!SCAMIN0!SORDAT07-MAR-1992!SO
RINDNOS,graph,12366!VERLEN0.000000!▲FS_AA00056NE▲00244 D
00065   330400010060000BID019006ATTF141025OBPT013166▲
2▲FE_AA00001PSBOYLAT▲BOYSHP1!COLMAR3!OBJNAM4!RECDAT11-MAR-1
994!RECINDNOS,alph!SCAMAX20000!SCAMIN0!SORDAT28-OCT-1992!SO
RINDNOS,report,NM4492,12366!VERLEN0.000000!▲FS_AA00001NE▲00
094 D     00055   330400010060000SEGT011006SG2D022017▲
3▲FS_AA00001▲40.881527!-73.785361!▲00321 D     00065
330400010060000BID019006ATTF218025OBPT013243▲
4▲FE_AA07025PSLIGHTS▲COLOUR4!HEIGHT46.000000!LITCHR1!MARSYS
2!OBJNAMSTEPPING STONES
LT!RECDAT07-MAR-1992!RECINDNOS,digi!SCAMAX20000!SCAMIN0!SEC
TR10.000000!SECTR20.000000!SIGPER0.000!SORDAT07-MAR-1992!SO
RINDNOS,graph,12366!VALMXR0!VALNMR11!▲FS_AA10920NE▲00275 D
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PER4.000!SORDAT02-DEC-1992!SORINDNOS,report,NM4992,12366!VA
LMXR0!VALNMR10!▲FS_AA00002NE▲00094 D     00055
330400010060000SEGT011006SG2D022017▲
6▲FS_AA00002▲40.825111!-73.774583!▲00296 D     00065
330400010060000BID019006ATTF193025OBPT013218▲
7▲FE_AA07029PSLIGHTS▲COLOUR3!HEIGHT23.000000!LITCHR2!OBJNAM
46!RECDAT07-MAR-1992!RECINDNOS,digi!SCAMAX20000!SCAMIN0!SEC
TR10.000000!SECTR20.000000!SIGPER5.000!SORDAT07-MAR-1992!SO
```

This figure is partial data and not the complete document.

3.5 Data Characteristics

IHO S-57/DX-90 objects, attributes, and their expected attribute discrete values will be held in a normalized database tables connected to ATONIS. Data will be used by the software to map ATONIS field values to DX-90 format values, (see Appendix B).

Expected volume of records:

Table	Number of Records
Objects (Feature Object Classes: object class name, six-character code of class name, single or composite object).	200
Object Attributes (for each object, an individual set of relevant attributes).	3000
Attributes (Feature and Meta Object Attributes: attribute name, six character code of attribute name, attribute sub-set designator).	150
Attribute Discretes (Expected Attribute Input: input description, input value).	15500

Example relationship of object to attributes, and attribute to imput values.

OBJECT CODE	ATTRIBUTES CODE (Many related to object: BOYLAT)	Input value - Meaning Many related to Attributes
BOYLAT (Buoy lateral)	1. BOYSHP (Buoy shape)	1 : conical/nun buoy 2 : can/cylindrical buoy ... 8 : ice buoy
	2. CATLAM (Category of lateral mark)	1 : port-hand lateral mark 2 : starboard-hand lateral mark ... 4 : preferred channel to port lateral mark
	...	...
	24. VERLEN (Vertical length)	0

4 OPERATING ENVIRONMENT

4.1 Equipment

The prototype software will operate on the CGSW. No additional hardware or software will be required. To demonstrate the complete functionality an ENC or ENC like prototype will be required. File transfer hardware/software to move files between CGSW and test ENC will also be needed.

5 DEVELOPMENT PLAN

5.1 System Testing

The prototype software will be tested to validate the findings of the feasibility study.

5.2 Personnel

The following personnel are assigned to this project.

L. Alexander	(R&DC)		
I. Gonin	(R&DC)	(35%)	
M. Dowd	(R&DC)	(40%)	of 16 hour week
W. Heerlein	(R&DC)	(10%)	
J. Bagwell	(UNISYS)	(100%)	for 6 months (need to extend to one year)

Estimates of percent of effort are shown in parenthesis.

5.3 Project Tasks

The following stages define the project's timeline.

DEFINITION STAGE

- Develop Functional Requirements Document.
- Develop test ENC definition.

DESIGN STAGE

- Develop ENC data model.
- Develop prototype ATONIS code specification.

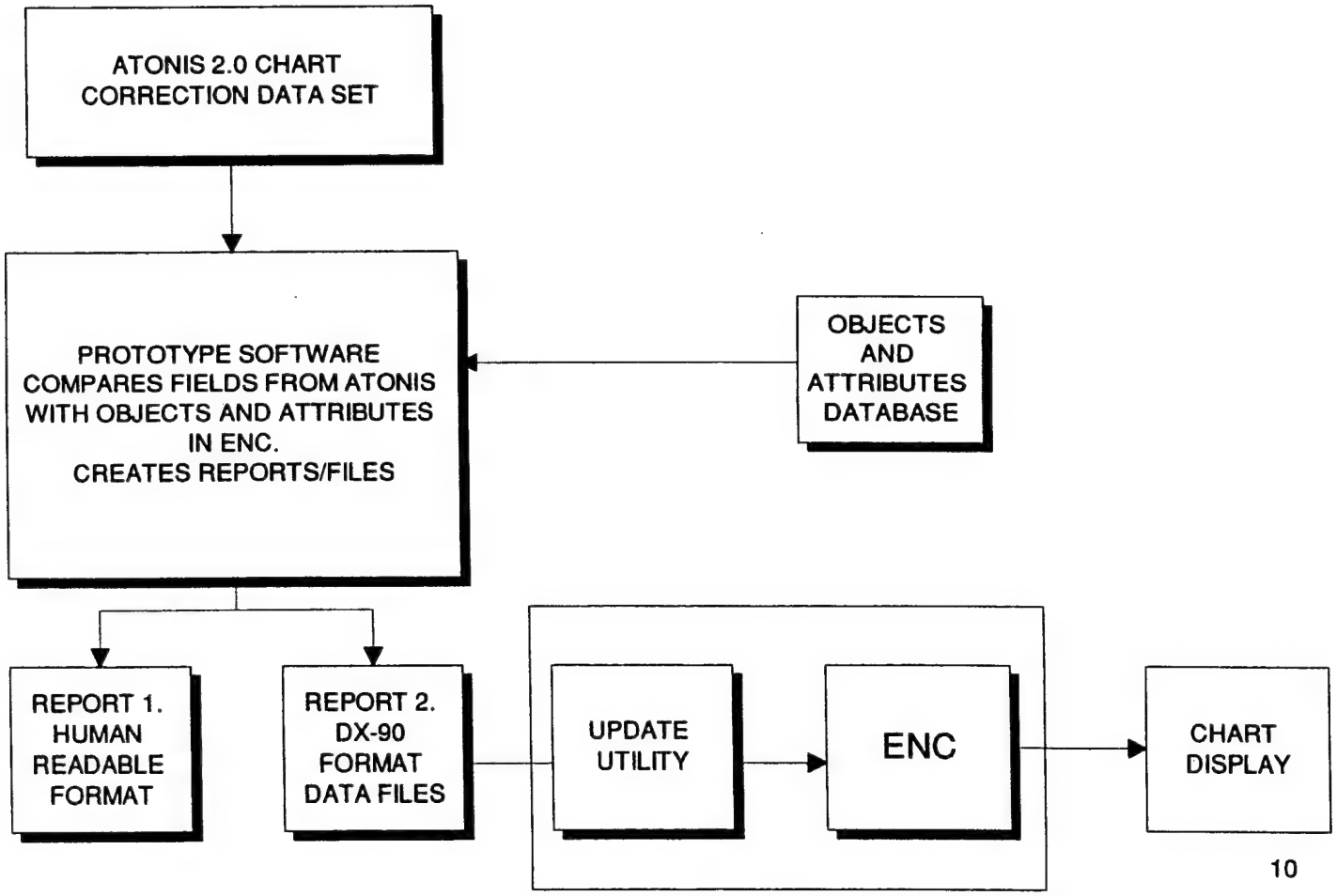
PROGRAMMING STAGE

- Code prototype ATONIS application module. Integrate into ATONIS.
- Test/Debug code.
- Demonstrate prototype system.

DATE	MILESTONE
1 Oct 1994	Project Start
1 Dec 1994	End Definition Stage
30 Dec 1994	End 1st FY95 Quarter
1 Feb 1994	End Design Stage
15 Mar 1995	Demo
30 Mar 1995	End Program Stage, 2nd FY95 Quarter

Appendix A

CONVERSION FROM ATONIS CHART CORRECTION TO DX-90



Appendix B

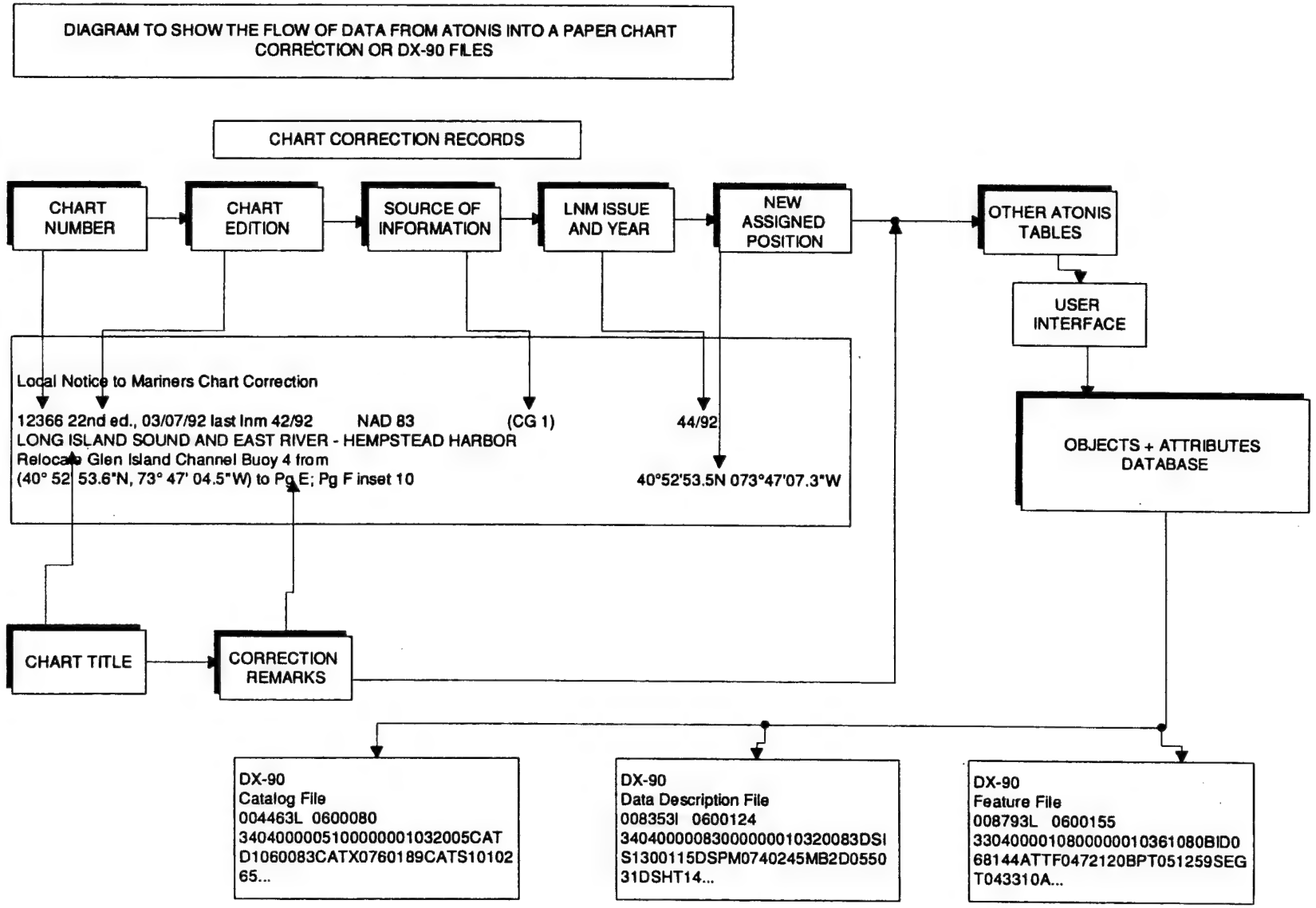


DIAGRAM TO SHOW THE FLOW OF DATA FROM ATONIS INTO A PAPER CHART CORRECTION OR DX-90 FILES
CHART CORRECTION RECORDS
CHART NUMBER
CHART EDITION
SOURCE OF INFORMATION
LNM ISSUE AND YEAR
NEW ASSIGNED POSITION
OTHER ATONIS TABLES
USER INTERFACE
OBJECTS + ATTRIBUTES DATABASE
Local Notice to Mariners Chart Correction
12366 22nd ed., 03/07/92 last lnm 42/92 NAD 83 (CG 1) 44/92
LONG ISLAND SOUND AND EAST RIVER - HEMPSTEAD HARBOR
Relocate Glen Island Channel Buoy 4 from
(40° 52' 53.6"N, 73° 47' 04.5"W) to Pg E; Pg F inset 10
40°52'53.5N 073°47'07.3"W
CHART TITLE
CORRECTION REMARKS
DX-90
Catalog File
004463L 0600080
340400000510000000 1032005CAT
D1060083CATX0760189CATS10102
65...
DX-90
Data Description File
008353I 0600124
340400000830000000 10320083DSI
S1300115DSPM0740245MB2D0550
31DSHT14...
DX-90
Feature File
008793L 0600155
330400001080000001 0361080BID0
68144ATTF0472120BPT051259SEG
T043310A...

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APPENDIX D - DESCRIPTION OF CREATING AN LNM-ER FROM ATONIS (April 1995)

IHO S57 OBJECT AND ATTRIBUTE DATABASE

IHO S57 standard consists of feature objects and attributes which describe hydrographic information. Since feature objects in S57 have many attributes, and these attributes are not unique a relational database design structure was chosen to avoid redundancy. Another factor contributing to a relational database design is the use of composite object in S57, were a composite object references one or more simple objects with one or more attributes. The database was developed in PROGRESS to be compatible with ATONIS. This database defines the file structure, records, fields and indexes for S57 data. Table D.1 shows some example relationships of S57 object to attributes, and attribute to data values.

Table D.1 - Example S57 Object to Attribute and Attribute to Data Values

OBJECT CODE	ATTRIBUTES CODE (Many related to object: BOYLAT)	DATA VALUES (Many related to Attributes)
BOYLAT (Buoy lateral)	1. BOYSHP (Buoy shape)	1 : conical/nun buoy 2 : can/cylindrical buoy ... 8 : ice buoy
	2. CATLAM (Category of lateral mark)	1 : port-hand lateral mark 2 : starboard-hand lateral mark ... 4 : preferred channel to port lateral mark
	...	...
	24. VERLEN (Vertical length)	0

CREATING CHART UPDATES FOR FEDERAL AND PRIVATE AIDS

The key to creating LNM-ER is to map the LNM chart correction records and fields to the S57 object and attribute database. When a chart correction is produced and it concerns an aid, information about that aid is taken from the federal or private aid table within ATONIS. The ATONIS chart correction record (chcorr_log) indicates which table to use to gather the necessary information to produce the chart correction. Another key field within ATONIS is aid type. From this field, it is possible to tell if an aid is fixed or floating. Both types of information are used to create a S-57 update file. At this point, a correction for an aid has been determined to be: federal or private and fixed or floating. Next the aid color is retrieved from the LNM chart correction log. Using the S57 object and attribute database, comparisons are made with the chart correction log. Other objects and attributes describing the aid are identified and values

are assigned to them according to information taken from ATONIS data records. Figure D.1 shows the process of creating an LNM-ER from a chart correction record within ATONIS.

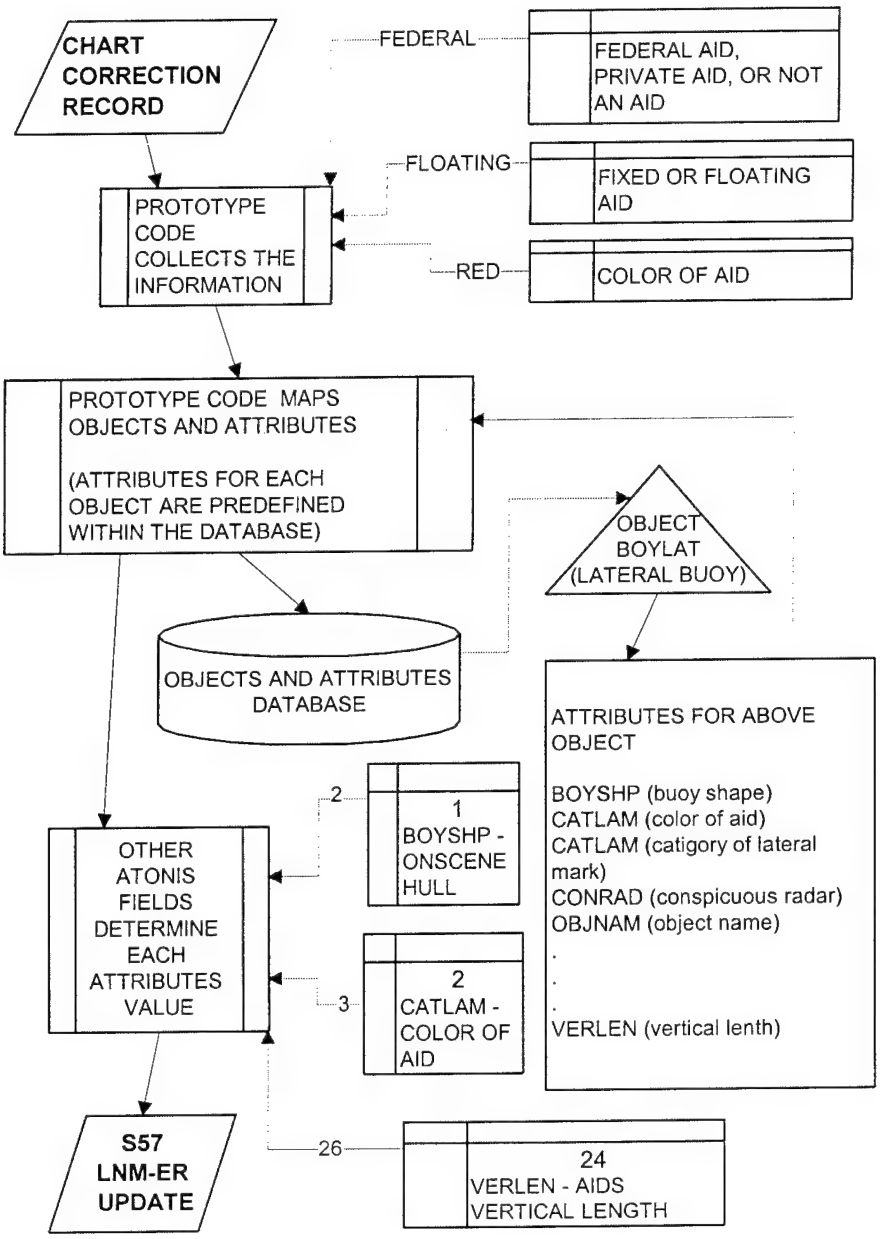


Figure D.1 - Process Flow from Chart Corrections to S57 LNM-ER Update

Within the chart correction record in ATONIS is the action to be taken for that chart correction (i.e. add, change, etc.). The approach taken by S57 at the time was to delete the entire record and than add the new record with the updated changes. Table D.2 shows the application software conversion of chart correction actions from existing LNM action field to S57 LNM-ER action field.

Table D.2 - LNM Action Field Conversion to LNM-ER

EXISTING LNM	S57 LNM-ER
ADD	ADD
CHANGE	DELETE & ADD
DELETE	DELETE
RELOCATE	DELETE & ADD
SUBSTITUTE	DELETE & ADD

On the surface this approach seemed straight forward. Upon closer examination it was discovered that certain information about the object being changed was not available from ATONIS. For instance:

- Information about the ENC record that must be deleted. This ENC record describes specific information about the ENC. For instance, information about the types of objects contained in the ENC and where to find the attributes describing these objects. This information is only available from the ENC itself.
- There are feature reference values and spatial tags which are created by the National Hydrographic Office that produced the ENC which are also required before an object can be deleted or added. These reference values and tags are unique to the object. In order to create an update to that ENC (i.e. LNM-ER) these values and tags are needed.

In order to use this approach to produce LNM-ER for an ENC, the USCG has several options. They could maintain a database of all the ENC's they are responsible for providing updates to. In this way the missing information for the S57 LNM-ER update could be retrieved from the ENC database. The USCG could also work with NOAA (i.e. the national hydrographic office for the US) to get the missing information.

Since this approach was only a recommendation in S57 standard, we continued our investigation looking at other approaches which would more easily allow for the creation of ENC updates and could be proposed to the standards committees. We also wanted to learn more about the feasibility of ATONIS to support non-aid updates as well.

CREATING CHART UPDATES FOR NON-AIDS

The non-aids chart correction can be extremely diverse in the type of information required. In general, the individual (i.e. at each district) creating the chart correction in ATONIS, uses free form text fields to describe the non-aid correction. The variations allowed with free form text makes it very difficult to properly map these types of corrections to the S57 database. Structured fields with additional information would have to be added to ATONIS. For example:

- Standard text statements are required, especially for the more common objects that are routinely corrected, such objects as: soundings and wrecks.

- Even with a discrete set of text statements, some attribute values required by S57, such as: "SCAMIN" (i.e. chart scale minimum), "SCAMAX" (i.e. chart scale maximum), "PICREP" (i.e. pictorial representation) and "RECDAT" (i.e. recording date) will need to be added to ATONIS to allow for mapping of attributes required in a S57 update.

CHANGES TO ATONIS

- Topmarks descriptions appear in the Light List and should be a separate object for ECDIS purposes. To provide a full image set to S57, this information must be in ATONIS.
    * Add field topmarks_type for topmarks. Have "none" available as a discrete choice (i.e. NEW - aid_3.topmarks_type)

- Cardinal buoys and beacons are not specified in ATONIS. They are objects for ECDIS purposes. It is recommendation that there be another discrete in the aid_type field to provide a "cardinal" option.
    * Add discrete value "cardinal" to aid_type discrete list. If not used then indicates no cardinal buoy (i.e. AFFECTED - discrete table).

- Special purpose marks are attached to special purpose aids, but are not specified in ATONIS. ECDIS will have special purpose buoys and beacons and an attribute, called "CATSPM" that defines special purpose marks. It is recommended that a new field be created to this information. The discrete list should come from the S-57 attribute expected input values.
    * Add field sp_marks for special purpose mark (i.e. NEW - aid_4.sp_marks).

- Add field verlen for vertical length of aid (water level to tallest point of the aid).
    * NEW - aid_4/pvt_3.verlen OR AFFECTED - rename structure_height to aid_1.aid_length, pvt_1.aid_length)

- ATONIS charts table provides detail about charts. It is recommended minimum and maximum scale data be added to the charts table.
    * Add fields scamin, for scale minimum and scamax, scale maximum to charts (i.e. NEW - charts.scamin and NEW - charts.scamax)

- Create a pick list to chcorr_log "N/A" category chart corrections to standardize the display for the paper publication and also make it possible to include this category into ECDIS updates.
    * Add a pick list of discrete text remarks to the remarks section of the chart correction table to provide standard messages for chart corrections whose chcorr_log is "N/A" (i.e. AFFECTED - discrete table)

- ECDIS system processes the location of a chart correction using degrees decimal, rather than degrees, minutes, and seconds. The chart correction data in ATONIS stores locations to 1 decimal place on seconds, the aid tables store location seconds to 3 decimal places. Rounding errors could cause the ECDIS system to incorrectly position a chart correction.
    * Add 3 decimal places to chcorr_lat/long_seconds fields (i.e. AFFECTED - chart_corr.chcorr_lat_seconds chart_corr.chcorr_long_seconds)

APPENDIX E - TEST PLAN FOR ISSUES AND OPTIONS TESTED USING THE PROTOTYPE DISPLAY SYSTEM (May 1996)

Table E.1 - Summary of Issues and Options for Manual Updating - Parts 1 & 2

Issues for Manual Updating	Options
1. Format *Note: Two options for each of three variables*	Attributes Option 1) Only mandatory attributes are provided in update Option 2) Attributes listed in update include mandatory (but not necessarily all) and non-mandatory attributes. Latitude/Longitude format Positions are listed in: Option 1) degrees minutes, decimal minutes Option 2) degrees and decimal degrees S-57 terms in the ECU Option 1) Update is described using S-57 code names followed by text Option 2) Text equivalent only
2. Applying Manual Updates	Only one option was implemented and will be used in each scenario. When the mariner applies the updates, he/she will be modifying the System ENC (SENC). Survey question will be asked to explore this option and the possibilities of other options (i.e. overlays). *Examples: When the SENC is modified, the data is considered "smart". Do you feel comfortable changing (applying updates to) the SENC? Should manual update be an overlay? not smart data?*
3. Verification/ Error Checking: *Note: For verification two scenarios incorporating two options*	Option 1) check text against each object with information provided Option 2) check against information and check visually Survey questions will be used for evaluating the issue of error checking. *Examples: System requirements for handling: object not found or update applied to wrong object? Errors in the ECU update (i.e. lat/long incorrect)*
4. Colors and Symbols Displayed During Route Monitoring *Note: Both options can be toggled back and forth by the mariner at anytime* *Display legibility versus the ability to distinguish manual updates from ENC data are being*	Option 1) object is displayed with standard colours and symbols Option 2) object is displayed in ORANGE Each of the two options above have been implemented slightly differently for each of the updating actions (i.e. add, delete, modify and move) and are described below. **add:** Option 1) Object remains displayed as would normally be displayed (can highlight if desired). Option 2) Object is displayed in orange. **delete:** Option 1) Deleted object is removed from display (can highlight if desired). Option 2) Deleted object is display in original color with orange slash over symbol. **modify:** Option 1) Original object is no longer displayed Modified objects are displayed as would normally be displayed - can highlight if desired.

Issues for Manual Updating	Options
investigated	Option 2) Original object is displayed with an orange slash through it Modified objects are displayed in orange, offset by a user specified distance. **move:** Option 1) Original object is no longer displayed Moved objects get displayed in new location in original color - can highlight if desired. Option 2) Original object is displayed with an orange slash through it Moved objects get displayed in new location in orange.
5. Logging Information *Note: The content of the logged information is of interest.*	content Option 1) The following is appended to the log for each modification: time/date of application, record of update, object id, object type, object name, location (area-use first point), source of update information (I. e. LNM, ECU, Broadcast), mariner's name, as entered in update's dialog window. manual Option 1) Mariner enters information, ECDIS logs it and mariner OK's it Information concerning this issue will be raised through the survey. *For example: The log has: too much information? what should be taken deleted? too little information? information what should be added? Should it be impossible to get in (or out) of "updating mode" without a user id and password?*
6. Highlight (must be distinguishable from official **ENC data)**	These options are directly related to options implemented in issue four. Display legibility and the ability to distinguish manual updates from ENC data is addressed here again. Option 1) Object is displayed in ORANGE - therefor always highlighted Option 2) ORANGE circles (i.e. add, modify and move) or slashes (i.e. delete) appear when highlighting is requested
7. Manual Updates: Lines and Areas *Note: Investigation as to whether or not mariners need/want to modify line and area objects?*	Option 1) Show capability to modify, add or delete lines and areas The mariner will be given the opportunity to modify line objects and area objects as they did point objects. To further investigate this issue several survey questions will be asked. *For example: Is this a feasible process, or is it too cumbersome?* *Do you feel comfortable changing the chart this way?* *Is the first point for lines and areas enough? Something else better?*
8. Official (Automatic) Update replace Manual Update	1) mariner must remove the manual updates so automatic updates can replace them? 1)Mariner follows steps to undo each manual update. *Example of survey questions: Should the mariner or the ECDIS be responsible for removing manual updates prior to applying an official automatic update? Should all manual updates be removed or just those addressed in the official update?*

Table E.2 - Issues and Options for Automatic Updating - Part 2

Issues For Automatic Updating	Options
1. Format	The IHO S-57 standard specifies the format. Attribute 1) Only uses mandatory 2) Use mandatory plus/minus
2. Applying Automatic Updates	The ECDIS is required to automatically apply official updates. The ECDIS must also provide a tool to verify these updates. The following survey question will assist in investigating these requirements: *Does it matter when official updates are applied to the ENC as long as the latest update is applied when displayed? How long should an automatic update take to apply? What type of verification is needed?*
3. Official (Automatic) Update Replace Manual Update *Note: Issue as to the pros and cons of modifying the SENC or using an overlay for manual updates is being investigated.*	Option 1) Mariner must remove the manual updates so automatic updates can replace them? 2)Official updates replace the manual updates automatically? *Example of survey questions: Should the mariner or the ECDIS be responsible for removing manual updates prior to applying an official automatic update? Should all manual updates be removed or just those addressed in the official update? Should manual update be an overlay? not smart data? Should manual updates modify the SENC? smart data?*
4. Verification: for Automatic Updates	Option 1) a window of text listing updates applied to the ENC a) click on object in list to be verified and object turns ORANGE and is placed in view on the display (OK or Reject) b) click on object in list to be verified and object is circled in ORANGE (points) or outlined in ORANGE (lines) or a pattern filled in ORANGE (areas) - deleted objects do? or do not? appear? (OK or Reject) Option 2) No list is provided (OK or Reject) a) all updates for the ENC displayed are in ORANGE (OK or Reject) b) all updates for the ENC displayed are either circled in ORANGE (points) or outlined in ORANGE (lines) or a pattern filled in ORANGE (areas) (OK or Reject) *Example question: Can more than one object be selected from list?* Another sub-issue under verification is "saving". *Example question: At what point during the process of applying official updates should the SENC be "saved" by the ECDIS?*
5. Error Checking	There are no options implemented for this issue. Survey questions will be used for evaluating the issue of error checking. *Examples: System requirements for handling: object not found or update applied to wrong object? Errors in the ER update (i.e. lat/long incorrect)*

Issues For Automatic Updating	Options
6. Highlighting: for Automatic Updates	Option 1) Object turns ORANGE Option 2) ORANGE circles (i.e. add, modify and move) or slashes (i.e. delete) appear when requested
7. Colors and Symbols Displayed During Route Monitoring	Option 1) standards specifications state that updates must be represented in the same colors and symbols as other ENC information
8. Logging Information	content Option 1) The following is appended to the log for each modification: time/date of application, record of update, object id, object type, object name, location (area-use first point), source of update information (I. e. LNM, ER, Broadcast), mariner's name, as entered in update's dialog window. automatic Option 1) The ECDIS automatically logs update information and the mariner OK's it. *Example question: Should it be impossible to get in (or out) of "updating mode" without a user id and password?*
9. Updates for Multiple ENCs	There are no options implemented for this issue. *Example question: How does a mariner if he/she must display an the ENC before it is updated?*

APPENDIX F - A DESCRIPTION OF THE USCG R&D CENTER'S IMPLEMENTATION OF THE IHO S57 AND S52 STANDARDS ON THE PROTOTYPE DISPLAY SYSTEM (December 1996)

IHO S57 and S52 are the two primary technical standards that work together to make an ECDIS. S57 governs the format of the data (i.e. the ENC) and S52 dictates how the data is to be displayed.

ENC's (i.e. S57 chart data) are in a convenient and verifiable format for transferring chart data between a Hydrographic Office and an ECDIS. It is not, however, the most efficient means for displaying chart data on a display screen. For this reason, manufacturers (i.e. those implementing the ECDIS standards) usually choose to perform another conversion or translation to provide a more efficient process for displaying the ENC. We chose this route as well.

Individual ECDIS manufacturers are allowed to reformat, in a separate storage area, the information contained in the ENC for optimum system performance. The result of this reformatting is the System ENC (SENC). It is in the SENC that manufacturers can increase the desirability of their product through such measures as system speed, additional features, and desirable functions.

ECDIS is a class of equipment and not an individual system. For various reasons, primarily safety, it is necessary that the displayed chart information (i.e. the final output used by the mariners) be consistent across all systems, regardless of the source of the ENC or manufacturer.

This consistency is achieved through the use of IHO S52. S52 can be seen as an artist in residence and found in all ECDIS. It provides the necessary drawing instructions for displaying the SENC across all ECDIS devices.

This IMO Performance Standard for ECDIS ensures that a mariner will not have to learn a multitude of symbols and color specifications for the same chart objects (i.e. buoy, depth contour, etc.) depending on the ECDIS manufacturer. It also requires certain functionality, both by the system and for navigational purposes. The following lists some of the functionality we choose to implement on the prototype display system:

- Load and save the ENC and the SENC
- The creation of 6 Color Palette for viewing the screen at various times of the day and night.
- The ability to change scale (i.e. zoom in or out
- The two required symbol sets - simplified and traditional
- The ability to select for view various chart objects. The classifications supported by S52 were implemented. These are: display base, standard display, display all and text.
- Global data is used to customize the chart information depending on the size of the vessel (i.e. draft, length, beam, etc.) For instance:
    - SAFETY_DEPTH - the mariner selects the safety depth in meters for the vessel and the color of safe and unsafe soundings and depth areas will be colored differently

- SAFETY_CONTOUR - the line with of the contour closest and greater than your safety depth is made bolder. This data also determines if isolated dangers get displayed

- Manual updating was implemented with the ability to add, delete, modify or move an object. This included the ability to update, points, lines and areas.

APPENDIX F (Cont'd) - INTEGRATED NAVIGATION SYSTEMS PROTOTYPE DISPLAY SYSTEM PROGRAM SPECIFICATIONS & SOFTWARE DESIGN DOCUMENT (PS/SDD) January 1997

Project Element 2720.2.2
Electronic Navigational Chart

Prepared by PSI International Inc.
Michael Migdail-Smith
for the: United States Coast Guard
Research and Development Center
1082 Shennecossett Road
Groton, CT 06340 - 6096

Table of Contents

Section 1. GENERAL INFORMATION

1.1 Summary

The DX90 Display is to be an engineering tool for investigating the capabilities and limitations of various IHO standards for ECDIS. The system will be comprised of a graphical user interface (GUI) with scroll and zoom features upon which hydrographic objects (corresponding to DX90 data sets) will be displayed according to the IHO Colours and Symbols Presentation Library specifications. The object will be created using the object oriented paradigm within the Kappa development system on the Desktop Tactical Computer (DTC-2). Additionally, various ENC updating modules will be designed, developed and incorporated into the display system to help determine the best method of updating an ENC. The DX90 Display is not meant to be a fully functional Electronic Chart Display and Information System (ECDIS), but to contain a subset of ECDIS features as specified in reference 9.

1.2 Environment

The DX90 Display is being developed for the U.S. Coast Guard R&D Center's Navigation Systems Branch (NSB) by PSI International Inc. The software will be developed on the Desktop Tactical Computer (DTC-2) using the Kappa development system, and will be available to R&D Center personnel to test and evaluate display and updating requirements for ECDIS.

1.3 References

1. FIPS PUB 38,
2. A Study of the Applicability of DX90 for ECDIS in a UNIX Environment,
3. Electronic Chart Updating: Test Plan For An Evaluation Using ECDIS,
4. Canadian Hydrographic Service Vector Electronic Navigation Chart Product Specification,
5. Designing the Electronic Chart Display, R. M Eaton, The Cartographic Journal, Vol 30, Dec. 1993
6. IHO S 52: Appendix 1, "Guidance On Updating the Electronic Navigation Chart", Appendix 2, Edition 2, version 3, "Provisional Colour & Symbol Specifications for ECDIS",Annex A, "IHO ECDIS Provisional Presentation Library",
7. IHO S 57: IHO Transfer Standard for Digital Hydrographic Data, Version 2.0.
8. Performance Standards for Electronic Chart Display and Information System (Draft), IMO, NAV39/31, Annex 6, Sept. 29, 1993.

Section 2. REQUIREMENTS

2.1 Description

An ECDIS consists of five major components: the ENC Translation Software, the SENC Presentation Software, the SENC, the ECDIS Function Software and the display. The scope of this task includes the SENC Presentation Software and the ECDIS Function Software which will in turn produce the SENC and the display respectively. The ENC Translation Software has been developed in Kappa which transforms DX90 data sets into object (in the traditional object oriented manner, where the DX90 attributes represent the attributes of the data item) instances which can be linked to graphical objects. The functions of the DX90 display software is to link these objects to the graphic objects (built to S 52 specifications as part of this project) and display them on the GUI according to ECDIS standards and user requested functionality (also developed as part of this project).

2.2 Functions

The functions required by the DX90 Display include the capability to read and display DX90 data sets, provide zoom and pan features to the user, implement the Colours and Symbols Presentation Library (including the capability to change color schemes according to the time-of-day, modify the display according to operator selected safety contours and object preference), and to provide a test bed for experimenting with various SENC update methodologies.

2.3 Performance

The performance objectives for the identified functionality are broken down as follows:

2.3.1 Accuracy

Accuracy is required for the interpretation of the Colours and Symbols Presentation Library as well as the translation of DX90 data sets. Colours can only as accurate as monitor calibration will allow, however, the algorithms given some base calibration coefficients are expected to be exact. The accuracy of DX90 data sets are somewhat questionable, so translation of these data sets can only be expected within the limits of the available data. Finally, it is expected that symbols are accurately represented and displayed in accordance to IHO standards.

2.3.2 Validation

The output of the DX90 Display system is graphical. Therefore there can be no output data verification other that visual inspection. Input data will be examined prior to loading it into the DX90 Display system.

2.3.3 Timing

Due to the flexibility required by the DX90 Display system, timing will not be considered a requirement.

2.3.4 Flexibility

The flexibility of the DX90 Display system is paramount. The development environment of the IHO standards community may result in a great number of modifications to the standards both for the format of DX90 data input into the display system as well as the Colours and Symbols Presentation Library that drive the development of the graphic objects. The Kappa system is robust enough to provide an open environment for incorporating such changes. Major modifications to either standard may impact development time, however.

Functionality requirements are somewhat stable, with the exception of the SENC update methodology, which is still being researched. The update module within the DX90 Display system is expected to remain flexible enough to foster such research.

Section 3. OPERATING ENVIRONMENT

3.1 Equipment

The DX90 Display will be developed on the SUN DTC-2 and HP 9000 series, model 700 workstations. Additionally all existing data transfer networks currently in existence at the USCG R&D Center may be employed to transfer existing data from IHO and various

providers of ENC data sets (including output from the ATON ENC Update feasibility study).

3.2 Support Software

The DX90 Display will be developed in Kappa, a software development tool developed by Intellicorp. Kappa utilizes the combination of object oriented paradigms and X Windows to provide and environment for object base coupled with graphical display/interface development. The latest release of Kappa (version 3.1) is available but requires the Solaris operating system (version 3.2). It has yet to be determined if the upgrade is an absolute requirement to the system. Version 3.1 will run on the HP 9000 platform.

3.3 Interfaces

The DX90 Display interfaces with the following: the DX90 to SENC Conversion Software, its corresponding knowledge base, DX90 data sets, and the ATON ENC Update feasibility study output.

3.4 Security and Privacy

There are no security requirements imposed on this software.

3.5 Controls

There are no operational controls imposed on this software.

Section 4. DESIGN CHARACTERISTICS

4.1 Operations

The operating characteristics of an ECDIS system in general will be the bridge of a large ocean going vessel. It will operate in conjunction with radar, DGPS, etc. The DX90 Display prototype, however is non-operational (e.g. experimental) and thus will be used solely within a general office environment. The operator is expected to interface with the system through a MS Windows like menu structure, a mouse, an occasional keyboard input to information screens.

4.2 System/Subsystem Logic

The logic flow of the DX90 Display prototype is illustrated in Appendix A. Appendix 1 contains flow diagrams illustrating the processing or structure (i.e. menu structure) of each of action available to the user via the User Interface. The first figure is a overview of how the entire systems fits together. The software modules identified in this diagram are detailed in section 5 of this manual. The remainder of the flows follow the ensuing convention:

Shadowed boxes refer to further processing,
Rounded boxes are routine entrances and exits,
Rectangular boxes refer to process statements,
Hexagonal boxes represent a loop structure,
Diamonds indicated decisions,
X'd circles represent junctions,
Cylinders stand for input data, and
Trapezoids indicate user inputs.

Section 5. PROGRAM SPECIFICATIONS

The proposed software will consist of four modules: the SENC Presentation Software, the SENC Graphic Object Knowledge Base, the Display Function Software, and the SENC Update Routines. Appendix B contains flow diagrams illustrating the processing or structure (in the case of the Knowledge Base) of each of these modules. In addition to the structure describe in section four, the flow of the knowledge bases contain all attributes (or slots) within the box surrounded by a dashed line, while children, which inherit all of the attributes, are flowed to the right in a diagonal line tree structure.

5.1 DX90 to SENC Conversion Software

DX90 data sets will be converted to Kappa objects by the DX90 to SENC Conversion Software which will reside on the dgps HP and will be written in C from within the Kappa environment. Processing for this function is illustrated in figure 2.6. The structure of the Chart KB, where the converted objects will be stored, is illustrated in figure 2.3.1.1.

5.2 SENC Presentation Software

The Presentation software is responsible for linking the SENC objects created for a given DX90 data set to the SENC graphic object data base. Reference 7 provides conversion Look-up Tables and Symbology Procedure Diagrams that form the guidelines for converting SENC data into display instructions. Figure 1: Display Generator Concept in reference 7 provides a descriptive flow of this procedure. The logic required here will be embedded in the SENC Graphic Link Knowledge Base (SGL KB), whose structure is displayed starting with figure 2.4.2.1.

The SENC Presentation Software is a combination of the code that builds the SGL KB from the Look-up table, inputs and links the classes of this structure to the corresponding classes in the Chart KB (DX90 objects) and the PresLib KB (graphic objects), as well as various methods resident in each KB for the purpose of creating related instances in the other KBs and setting up the appropriate slot values for display purposes. These methods overlap into the Display Function Software. See figure 2.5.1 for an illustration of the SGL KB.

The specific requirements of the SENC Presentation Software is to implement the requirements of the Look-up Tables in the following fashion: Each object in the SGL KB will represent a unique entry in the Look-up Tables, named according to its numerical entry ID. The code will be responsible for attaching the object to the appropriate branch determined by the entry's area, point or line identifier combined with the Traditional or Simplified indicator. The DX90 object identifier will be stored and used to find the corresponding class in the Chart KB. Both the Chart KB and the SGL KB will maintain lists to represent this linkage. The attributes provided in the Look-up Tables will be stored in the *Attributes* slot so the CreateSGLInst method (Display Function Software) can match up the appropriate attribute values. Each symbolic instruction will result in the locating of an appropriate graphic object identified by the instruction, and storing the necessary data to support that object.

5.3 SENC graphic object data base

The SENC graphic object base will consist of several independent KBs: the PresLib, Colors, EcdisFonts, EcdisText, and EcdisLines KBs. Their structures are illustrated in figure 2.5.1. The Look-up Tables addressed in section 5.1 refer to lines and text as well as the symbols, lines and patterns defined in the Presentation Library. All references in turn refer to colors and fonts described in detail in S-52.

The IHO Colours and Symbols Presentation Library provide detailed drawing and coloring instructions for each symbol, line or pattern (including precedence and fill schemes). These objects make up classes of the PresLib KB. From these classes, the Presentation Software will generate instances with specific attributes such as position on the screen and angle of rotation and color. The PresLib KB is created as the corresponding tables, supplied with S-52, are loaded. The procedures associated with this action are Load functions which read in the tables associated with the Presentation Library and build the appropriate structure. They are flowed originating with figure 2.2.7.1.

The EcdisFonts KB will be created using the Kappa interface. It will consist of the font instances identified in the Look-up Table and will be labeled with the code corresponding to the "CHARS" parameter (described in section 7.1.2 of reference 7), preceded by "Ec". The differences between the classes will be determined by the size, width (bold or not), and font family. Two main branches, EcUnivers and EcTimes, will be created to link to the separates font families, "Univer" (only "Helvetica" is available in Kappa) and "TimesRoman", respectively.

The EcdisText KB will consist of objects in a one-to-one correspondence with the instances of the EcdisFonts KB.

The EcdisLines KB consists of classes labelled: DOTT, DASH, and SOLD, which corresponds to dotted, dashed and solid lines.

Colors will be created as objects where the actual mixture of red, green and blue is a function of, the operator selected, time-of-day. The graphic objects will reference the color objects directly so that coloration can be changed immediately. The procedures associated with this the Colors KB are the LoadColores function, which reads in the color tables and is flowed out in figure 2.2.7.2, and the change of time-of-day methods (update_colors), flowed in figures 2.2.3. Due to the difficulty in achieving Screen Calibration, initially, colors calibration coefficients will be estimated instead, thus although all colors will be represented for each time of day, they may not be exactly the same as the colors specified by IHO.

5.4 Display Function Software

The Display Function Software is responsible for displaying the graphic objects in the appropriate manner specified by the user. The user specifies the constraints through the following actions: selection of the SENC, the appropriate scale (or return to the previous view), the appropriate color palette (according to the time of day), the choice of traditional or simplified objects, the required safety contours and the list of object classes desired for display. Additionally, the user will have the ability to delete or save an SENC, zoom, or center, and there is an initialization function that loads all preliminary and necessary object bases, files and tables..

The selected SENC is a collection of objects, corresponding to an ENC (DX90 data set) and all associated updates, to be displayed. The user will be able to select the open function from the *File* menu selection (this menu will also offer *close* and *exit* options). Processing for this function is illustrated starting with figure 2.2.2. Upon selecting the open function, a list of stored SENCs will be presented from which the user may select one. Similarly, the user will be allow to load new ENC and all associated updates, This function is accomplished via the DX90 to SENC Conversion Software described in section 4.1 above. The initialization function, whose processing is illustrated starting with figure 2.2.7.1, will operate invisible to the user.

The user will be able to adjust the scale of the chart from the *Scale* menu selection. The default display for a given data set will be the Standard Display using the original ENC scale centered in the display window using the DAY_BLACKBACK color Palette. This display will establish a relationship between the graphic objects' lat/lon and screen locations. The user's options, which include selecting a scale, zooming in or out, specifying a scale or returning to the previous view, and corresponding processing are illustrated beginning with figure 2.2.6.1.1.

The user has the choice of traditional or simplified objects. The selection of one or the other will result in the retrieval of the appropriate symbol sets from the Presentation Library (this may be a one time feature as it involves the building the graphical object base).

The user can set the color palette (time-of-day) by selecting the appropriate item from the *ColorPalette* menu. The selection will be equivalent to the table headings in the Colours and Symbols Presentation Library: DAY_BRIGHT, DAY_WHITEBACK, DAY_BLACKBACK, DUSK_BLACKBACK, NIGHT_FILTERED, and NIGHT_UNFILTERED. This selection will activate the color intensity functions within each color object so the chart will be redrawn with a color scheme reflecting the operator's selection. The redrawn chart will still display the appropriate relationships between objects resulting from the current user parameters and overlap restrictions specified in S 52 and S 57.

The user will have the ability to display or remove from display classes of objects. The *Chart* menu will contain classes of objects which the user can select or deselect. Additionally, each class will contain a list of individual object types which the user can select or deselect. The classification will follow the scheme established by M. K. Dowd in the SENC (DX90) Knowledge Base.

Additional features include the display of detailed information of chart objects upon section of a chart area, as well as continuous display of the latitude on longitude equivalent of the pointer and the current scale. The user will be able to activate a selection menu by double clicking the mouse on an area of the chart. This feature will contain available update information and status. Figure 2.2.5 illustrates the options available to the user.

5.5 SENC Update

The SENC update module includes the ability to install updates to the ENC and manually create or modify object instances. The actual method for providing updates to the ENC (or DX90 data sets) is still under investigation so this feature will be experimental in nature and may change according to the needs of those investigating the ENC update procedures. Additionally, numerous options may be established, if necessary (all of which should be functional).

Current design is as follows: Only manual update capabilities are implemented in the current version of The Display Function Software. The manual update procedure is activated via a menu selection which will bring up a series of dialog boxes which guide the user through the process of creating or updating an object and placing it on the chart. Selections/functionality include add/insert, delete, modify/relocate, highlight, and undo. Additionally, the ability to save the chart corrections as part of the SENC fas been established and made available via a "File"menu option.

All manual updating functions, with the exception of highlighting, are performed in the "Manual Update" display mode, where all available chart object are made visible to the

operator. Access to the "Manual Update" display mode will require a password. Inorder to ensure accuracy, all locations can be entered as text, utilizing editors.

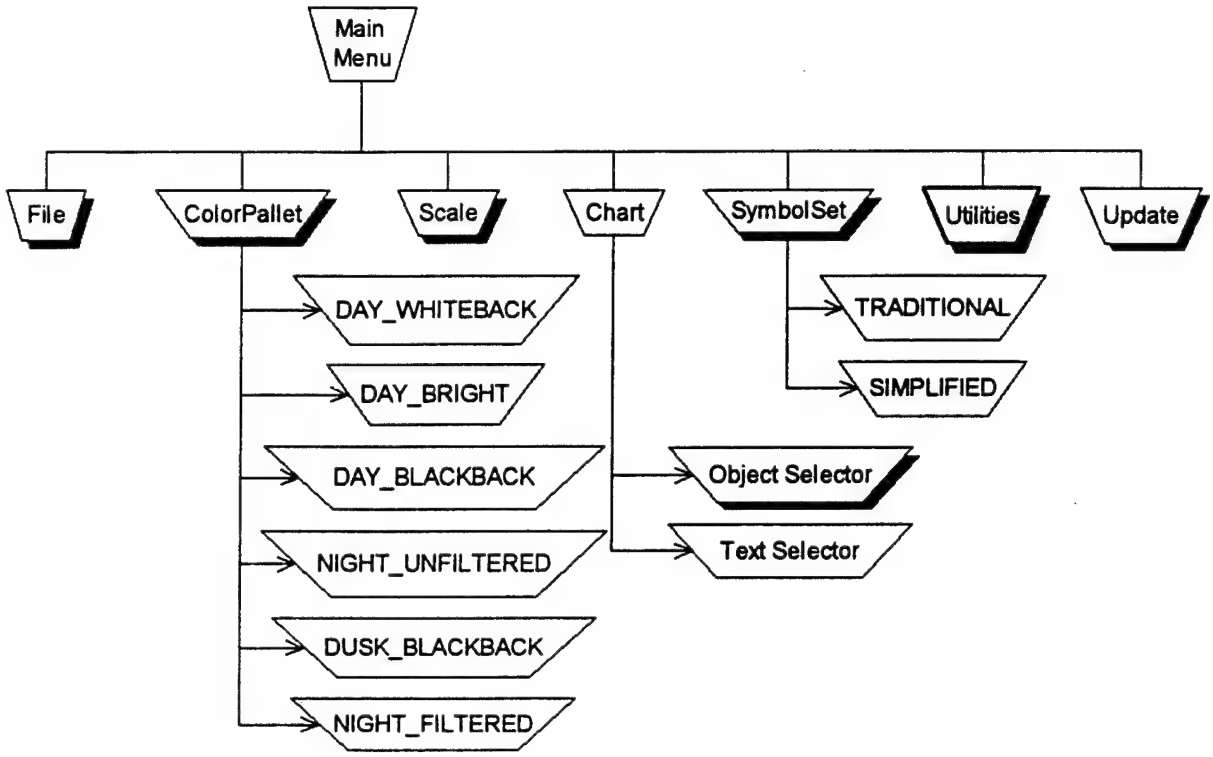
Two schemes have been designed for the display of manually updated SENC objects, while the Display System shall remain flexible in order to provide the opportunity to present updates using different display schemes. The two option chosen consist of the following:

A critical aspect of SENC updates is to log modifications so operators can quickly access updates. The update routines will therefore keep track of the changes it is undergoing. Some of this information will be included in the detailed information described in section 3.2.3. Additionally, a method must be established for warning users of modifications. This is also experimental for now.

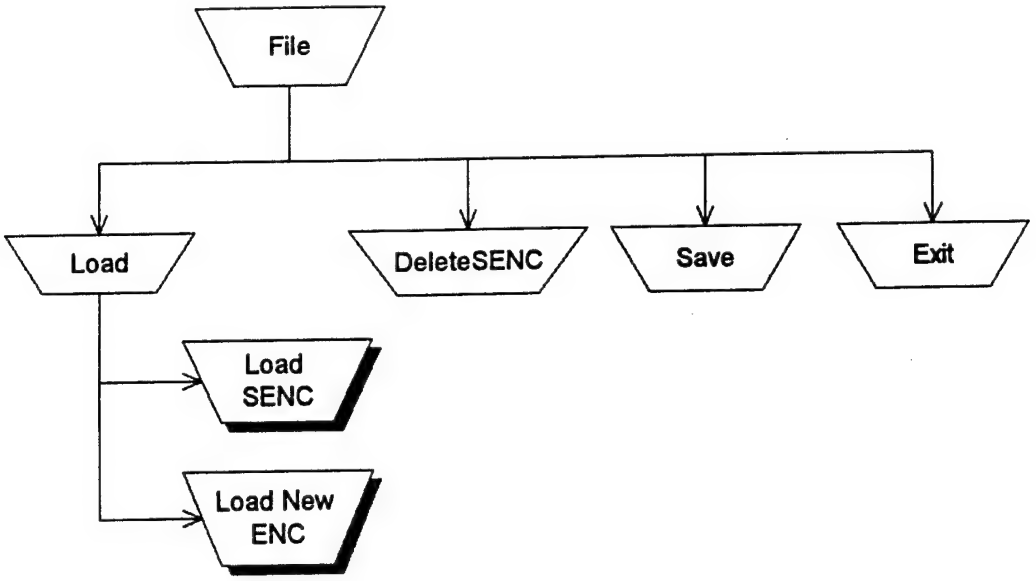
Program Specification/Software Design Document
Appendix A

ECDIS Display
Design Characteristics

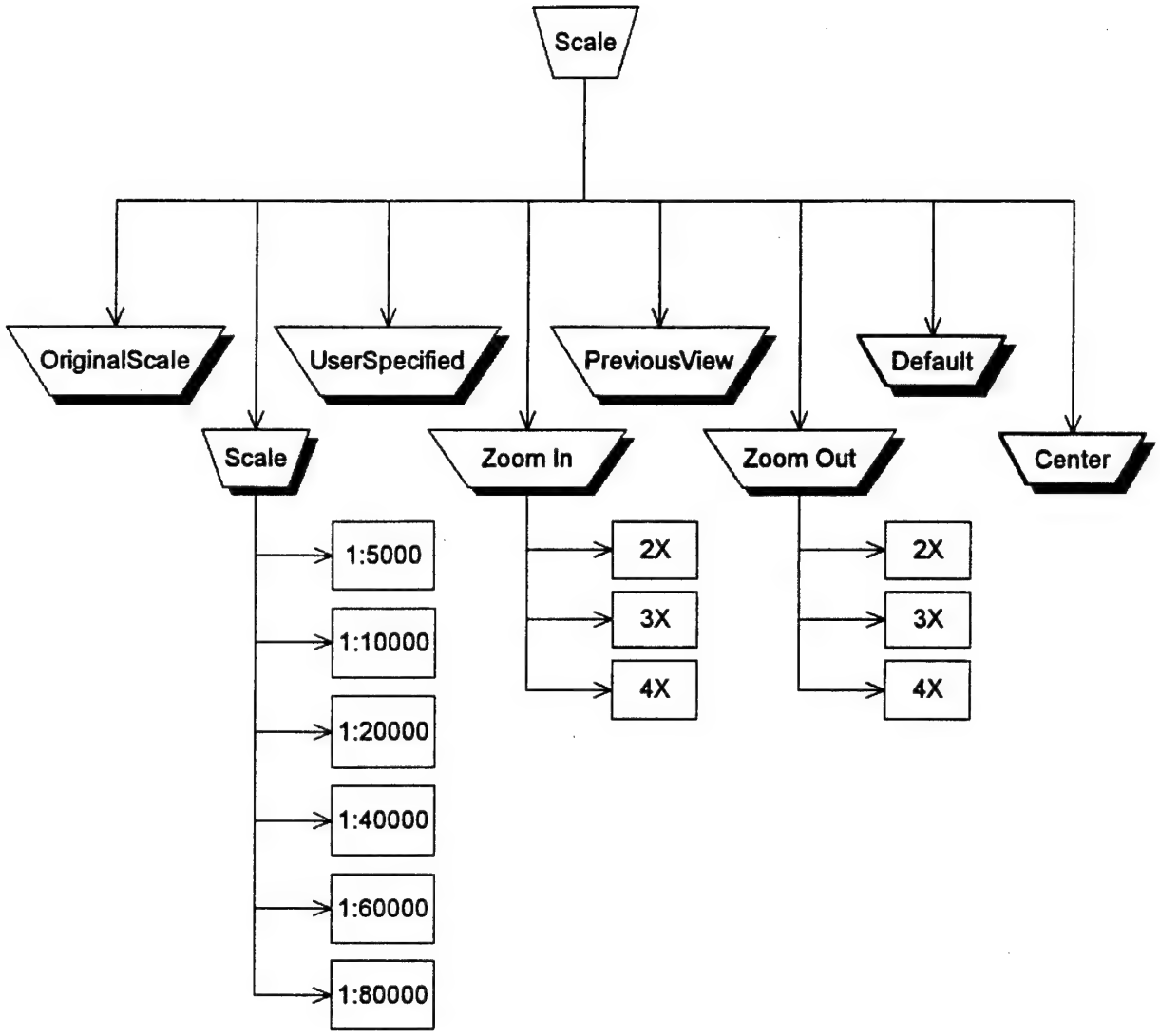
Menu Structure



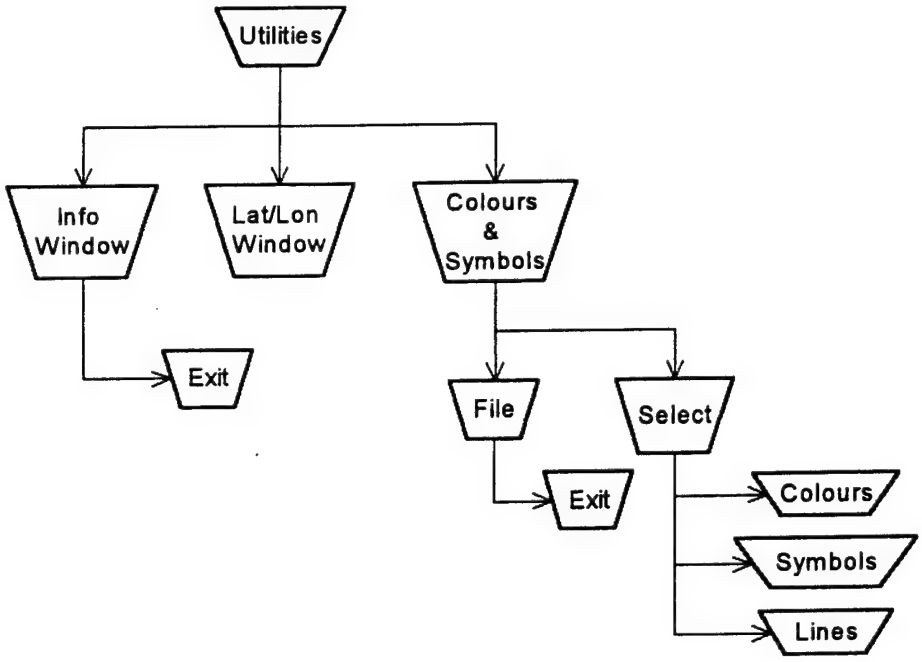
overview
figure 1.1



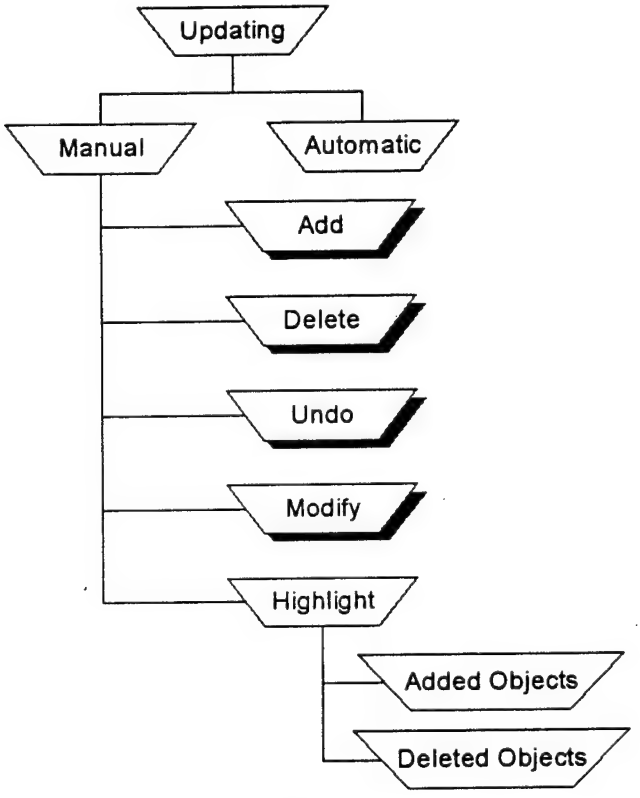
File
figure 1.2



Scale
figure 1.3



Utilities
figure 1.4



Updating
figure 1.5

Program Specification/Software Design Document
Appendix B

ECDIS Display
Program Specifications

DX90 Display System

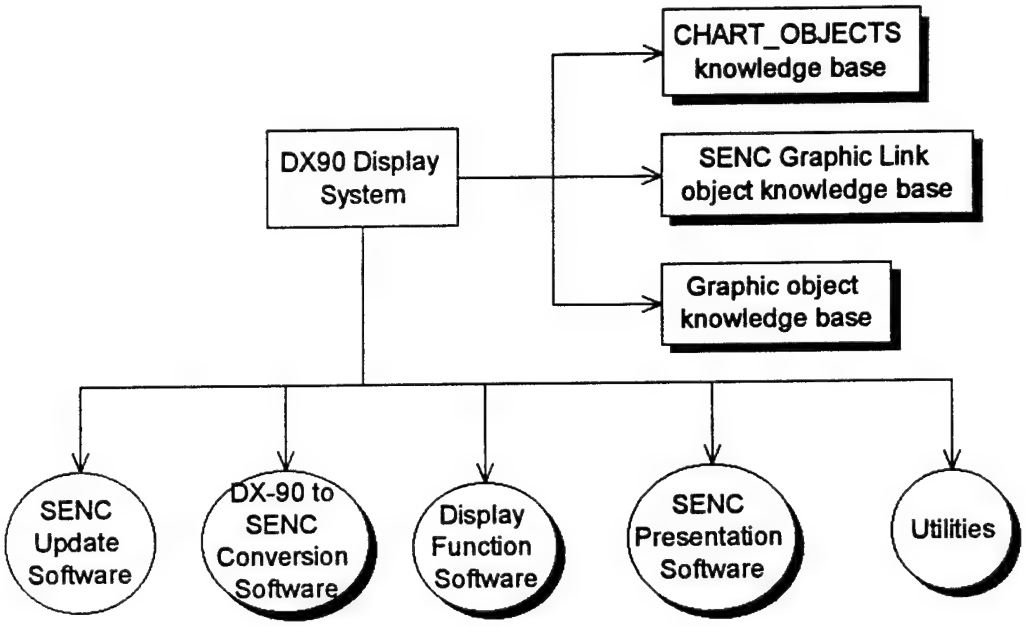


figure 2.1

Display Function Software

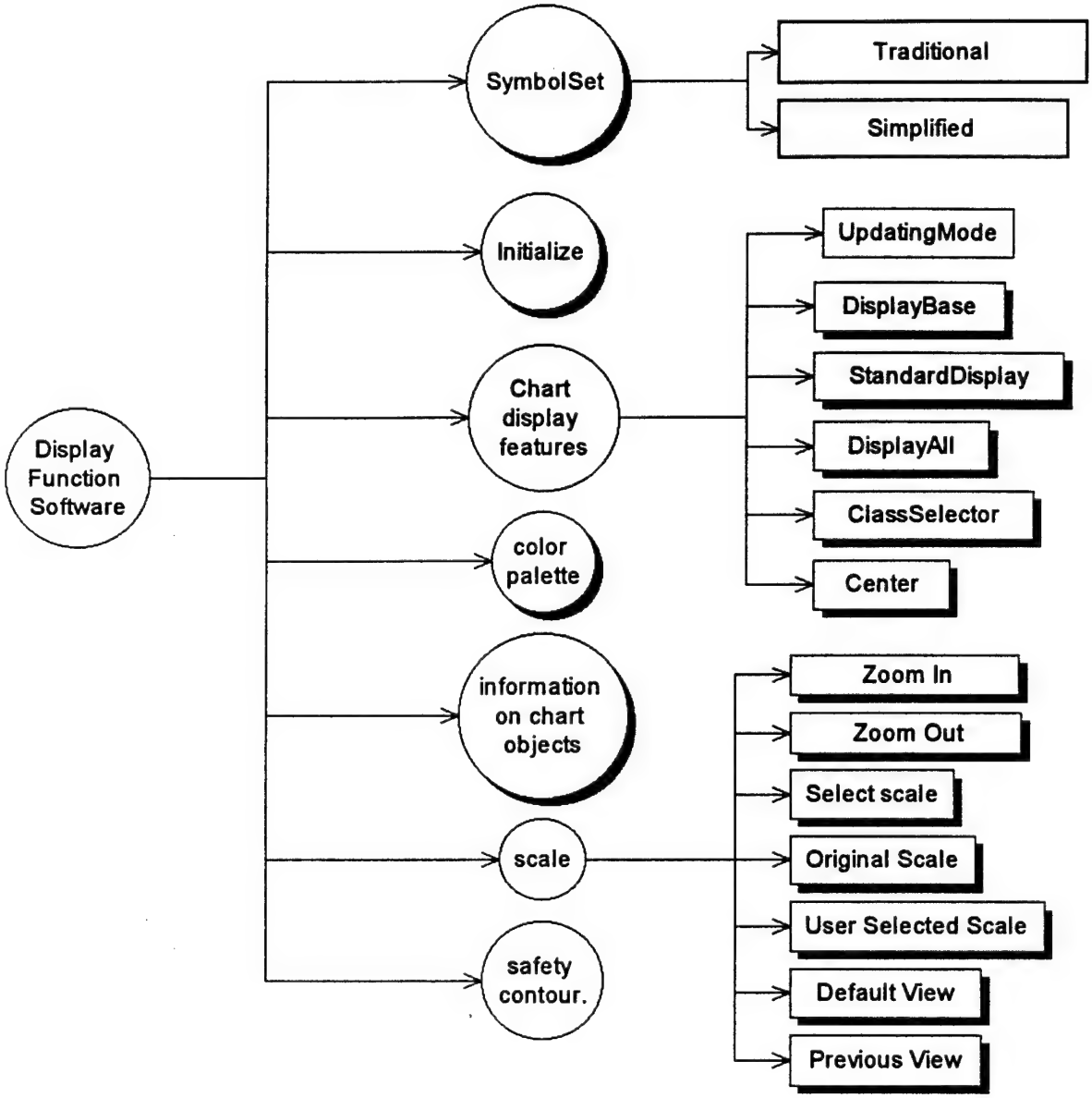
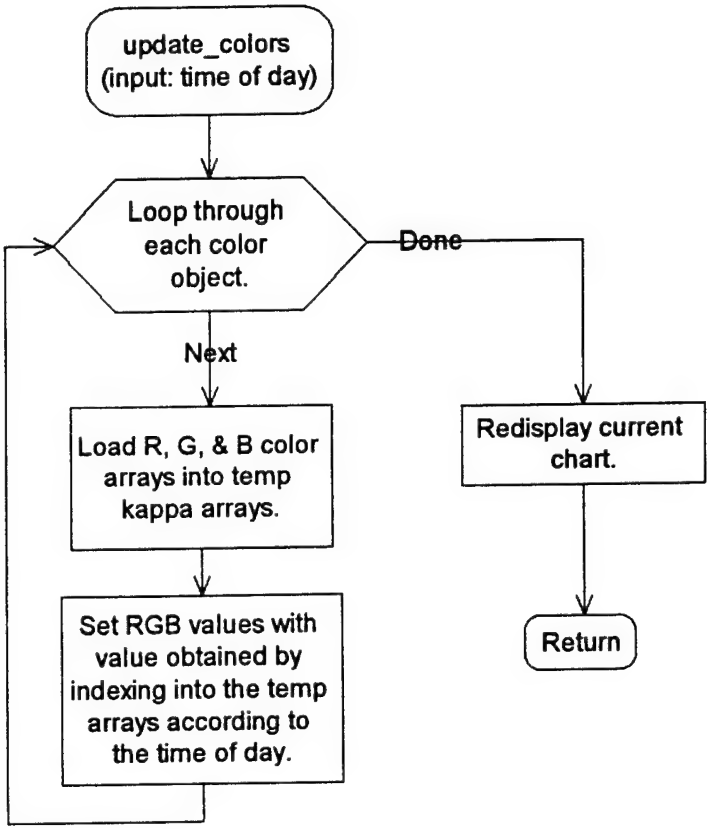
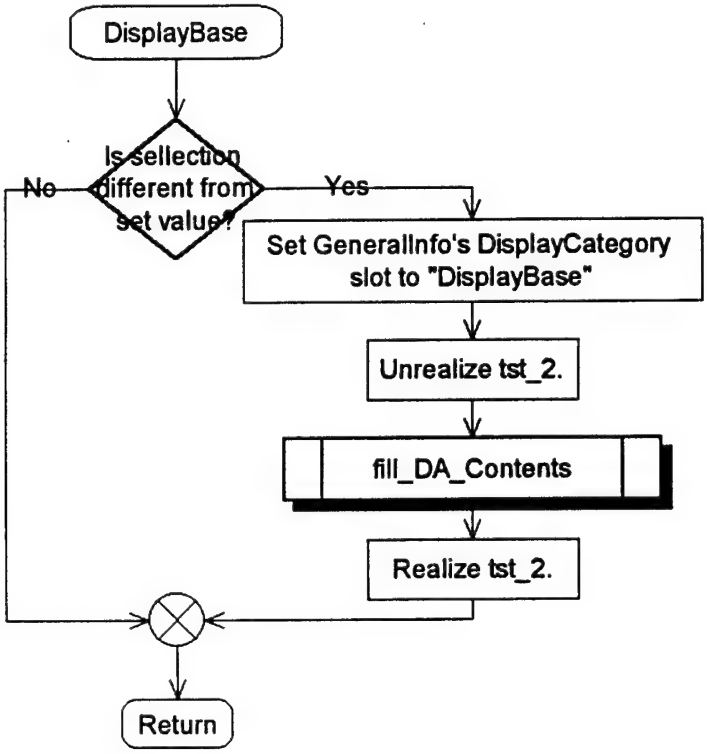


figure 2.2.1

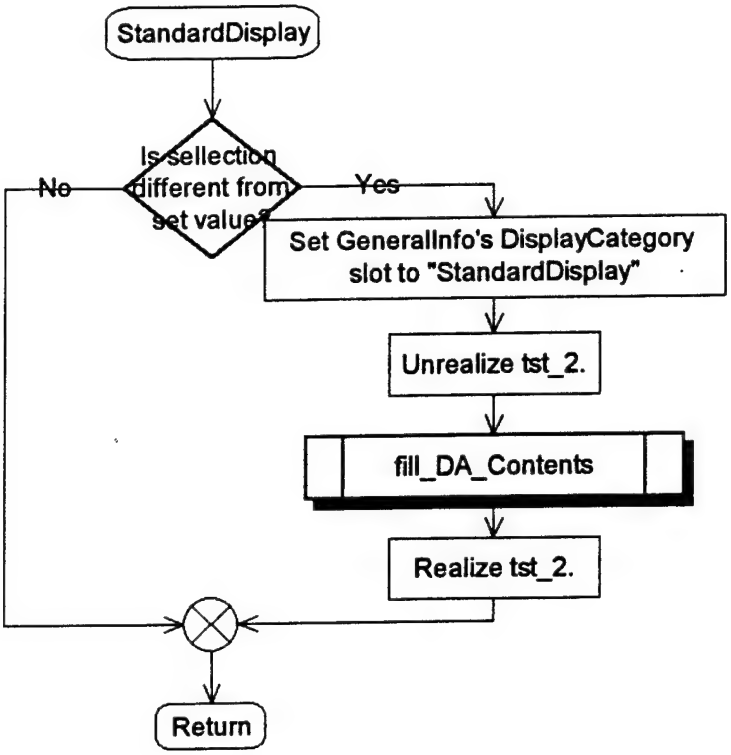
Color Palette



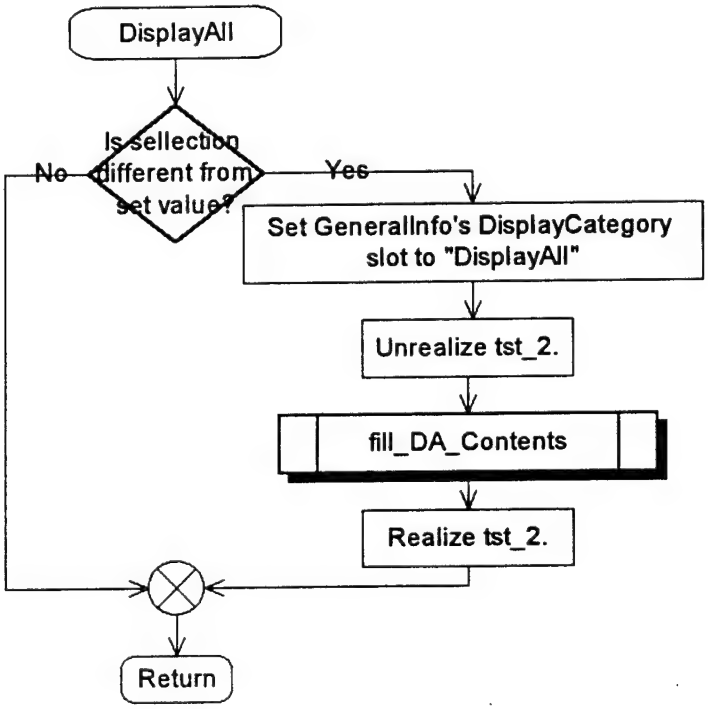
update_colors
figure 2.2.2



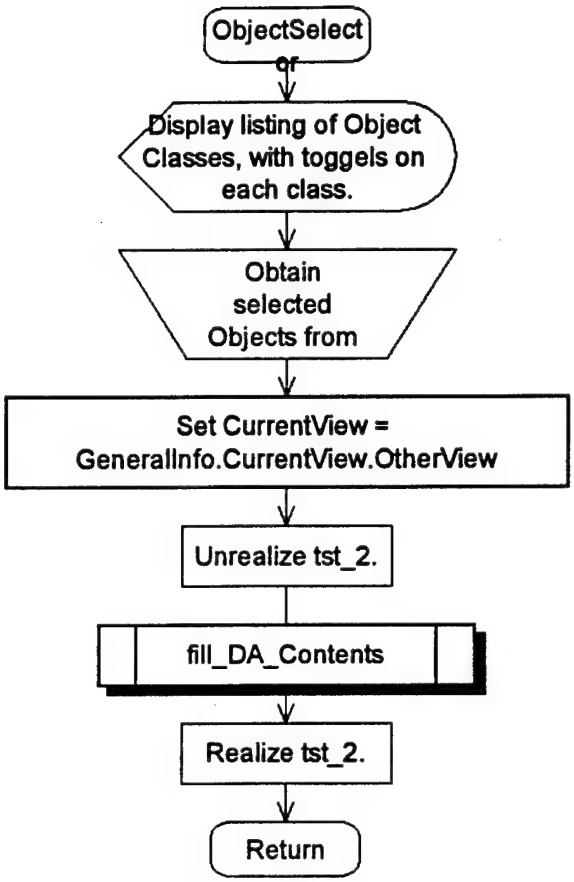
DisplayBase
figure 2.2.3.1



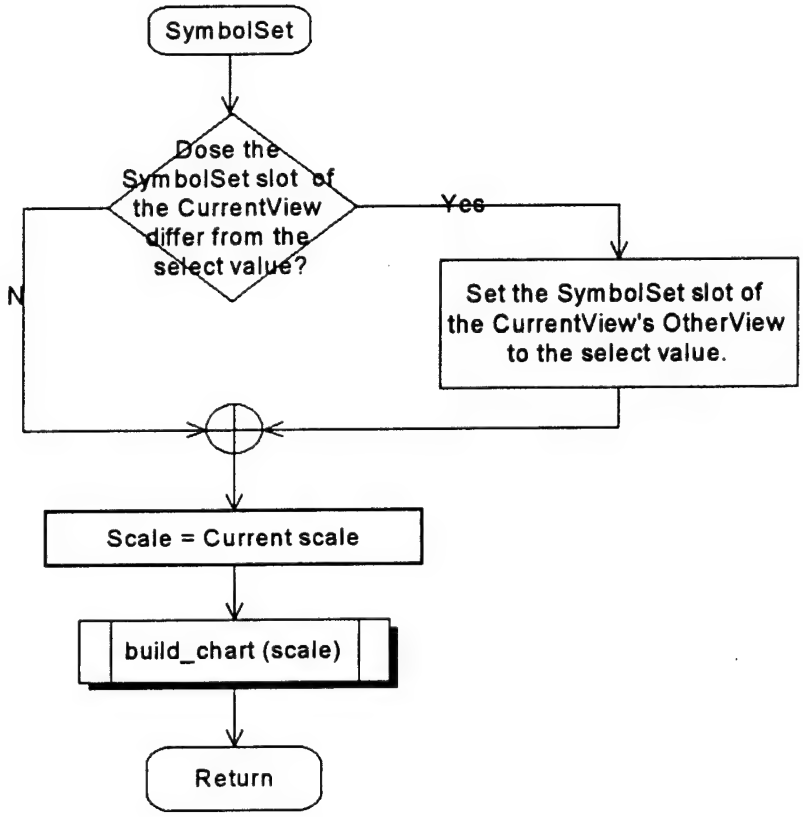
Standard Display
figure 2.2.3.2



DisplayAll
figure 2.2.3.3

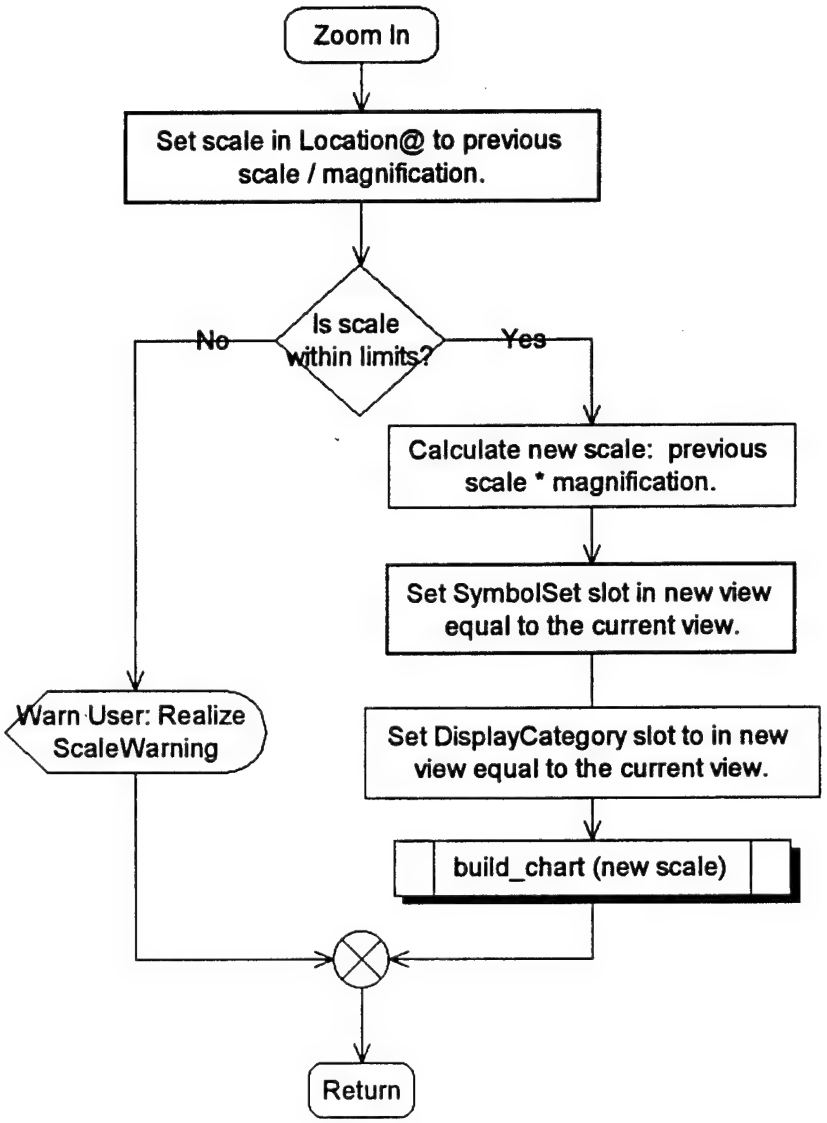


ClassSelector
figure 2.2.3.4

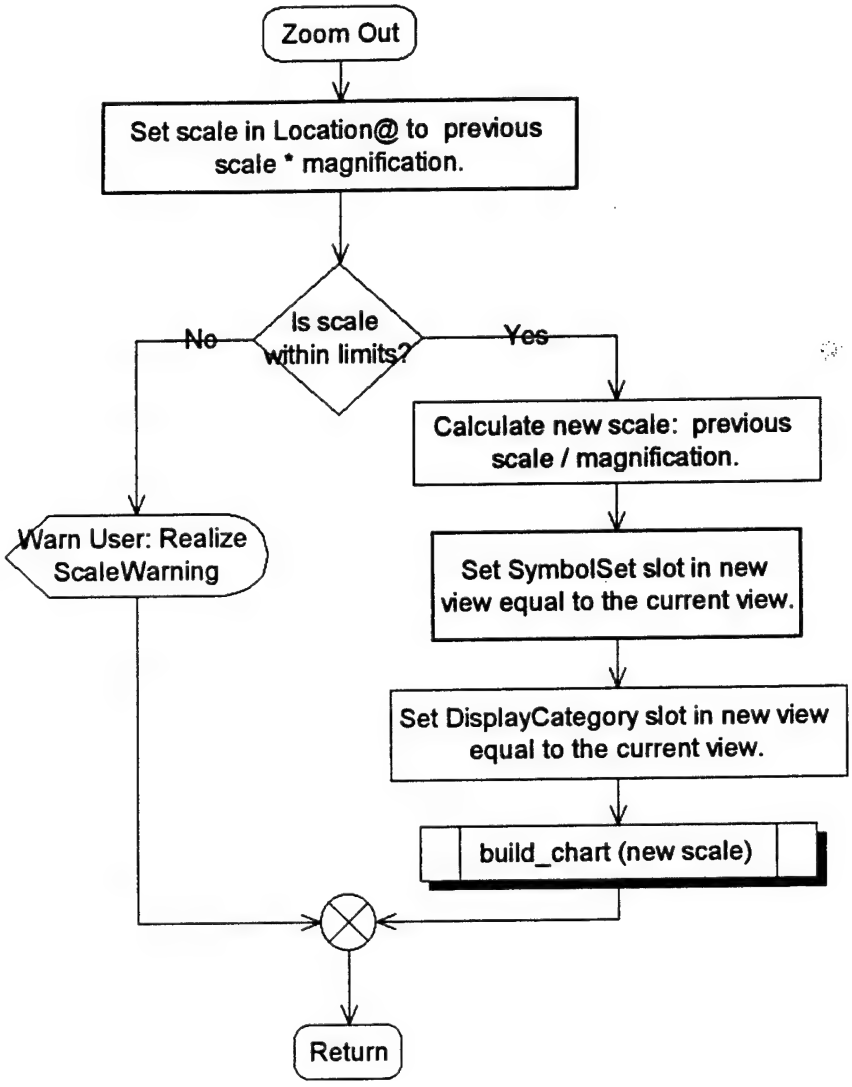


SymbolSet
figure 2.2.4

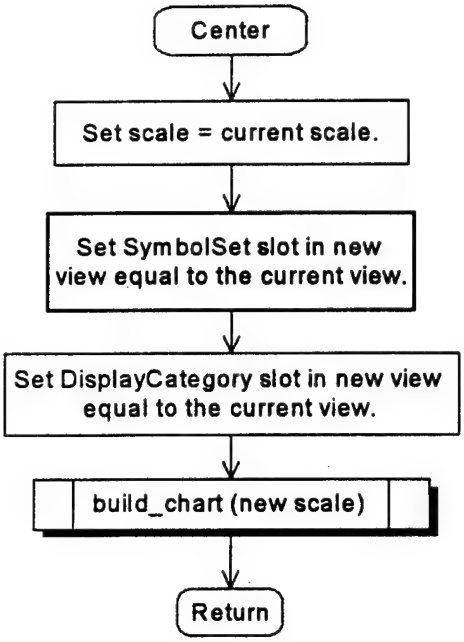
Scale



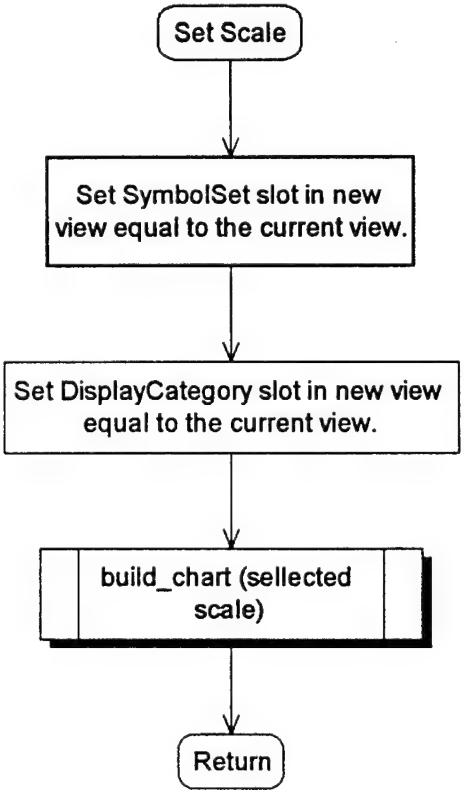
Zoom In
figure 2.2.5.1



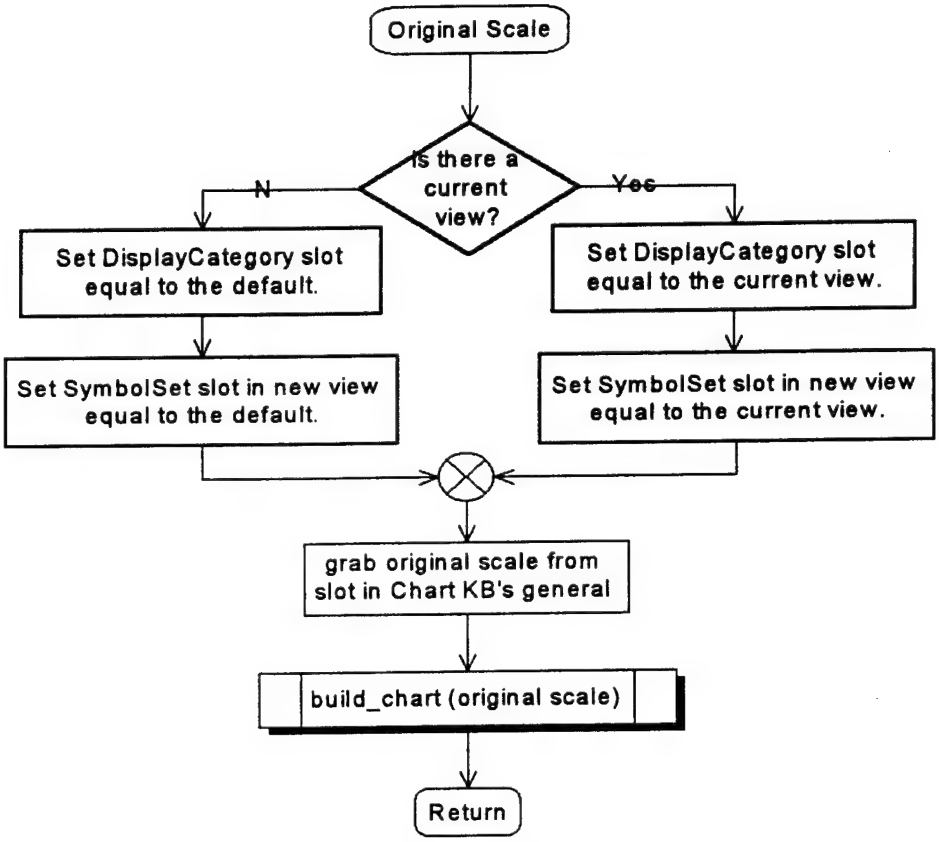
Zoom Out
figure 2.2.5.2



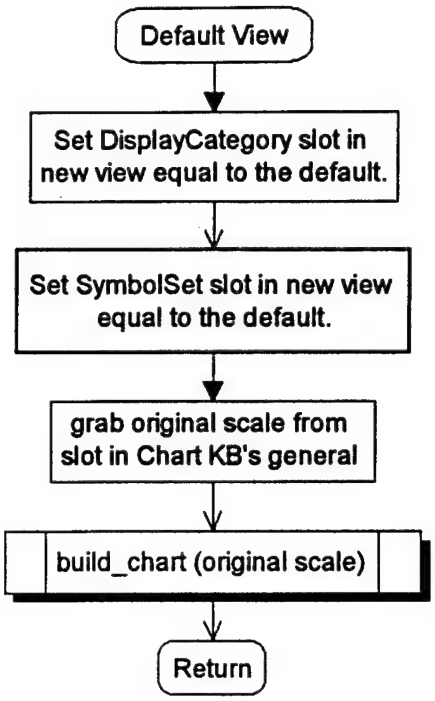
Center
figure 2.2.5.3



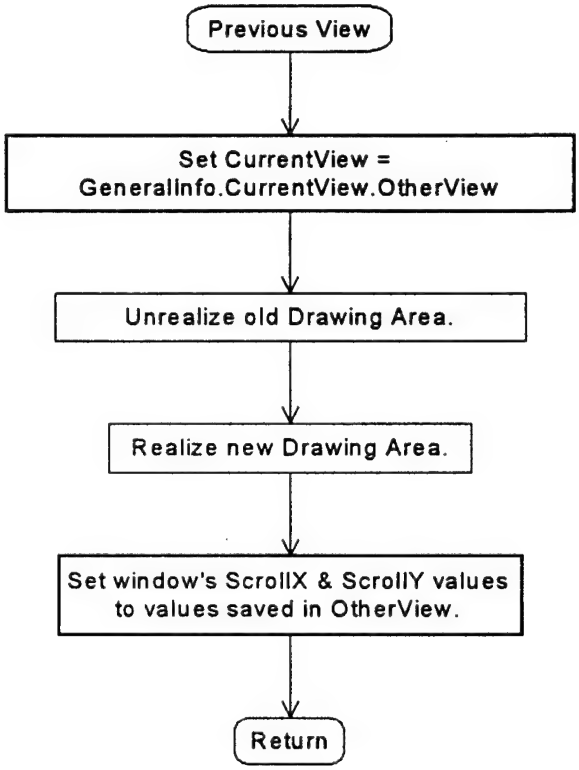
Select Scale
figure 2.2.5.4



Original Scale
figure 2.2.5.5

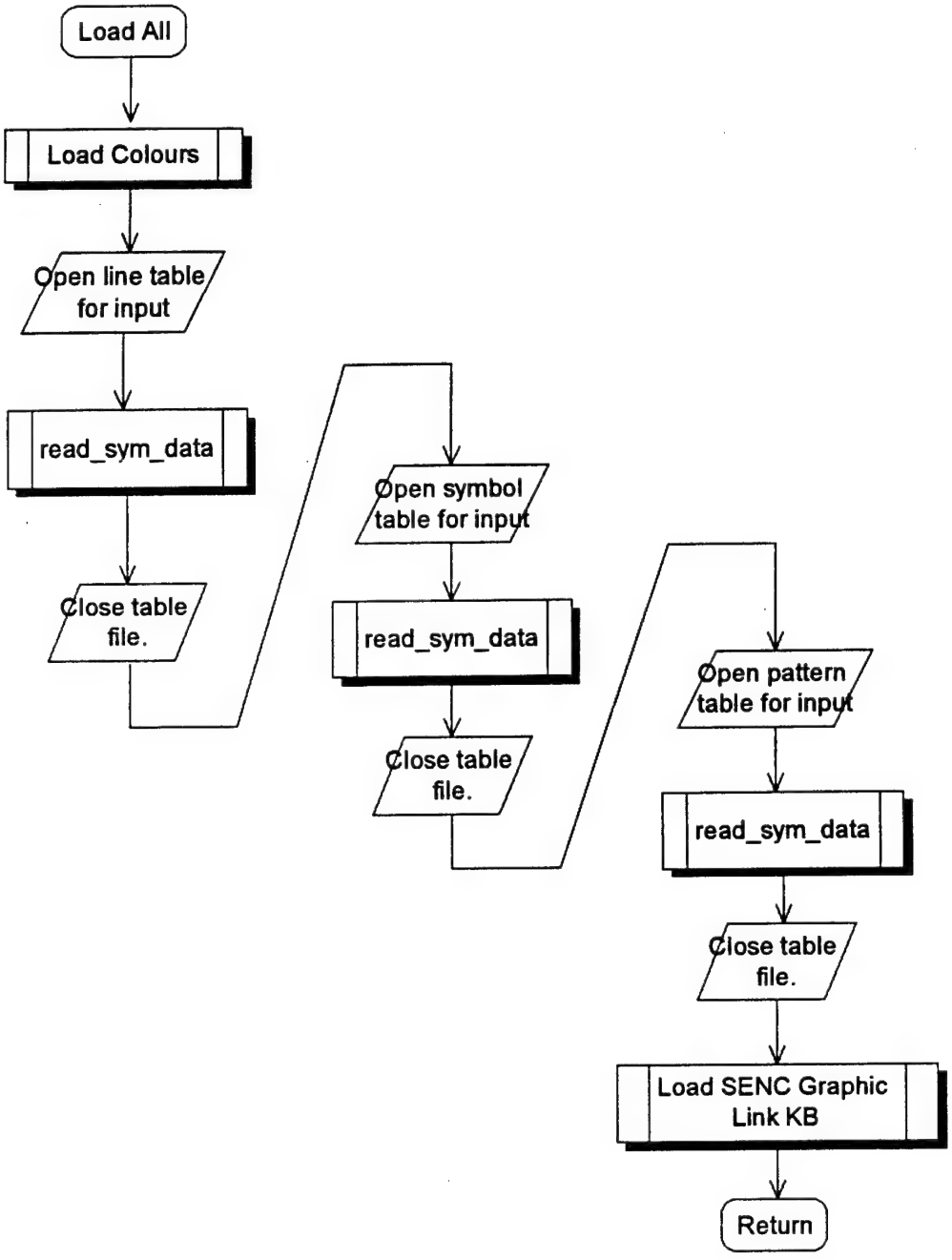


Default View
figure 2.2.5.6

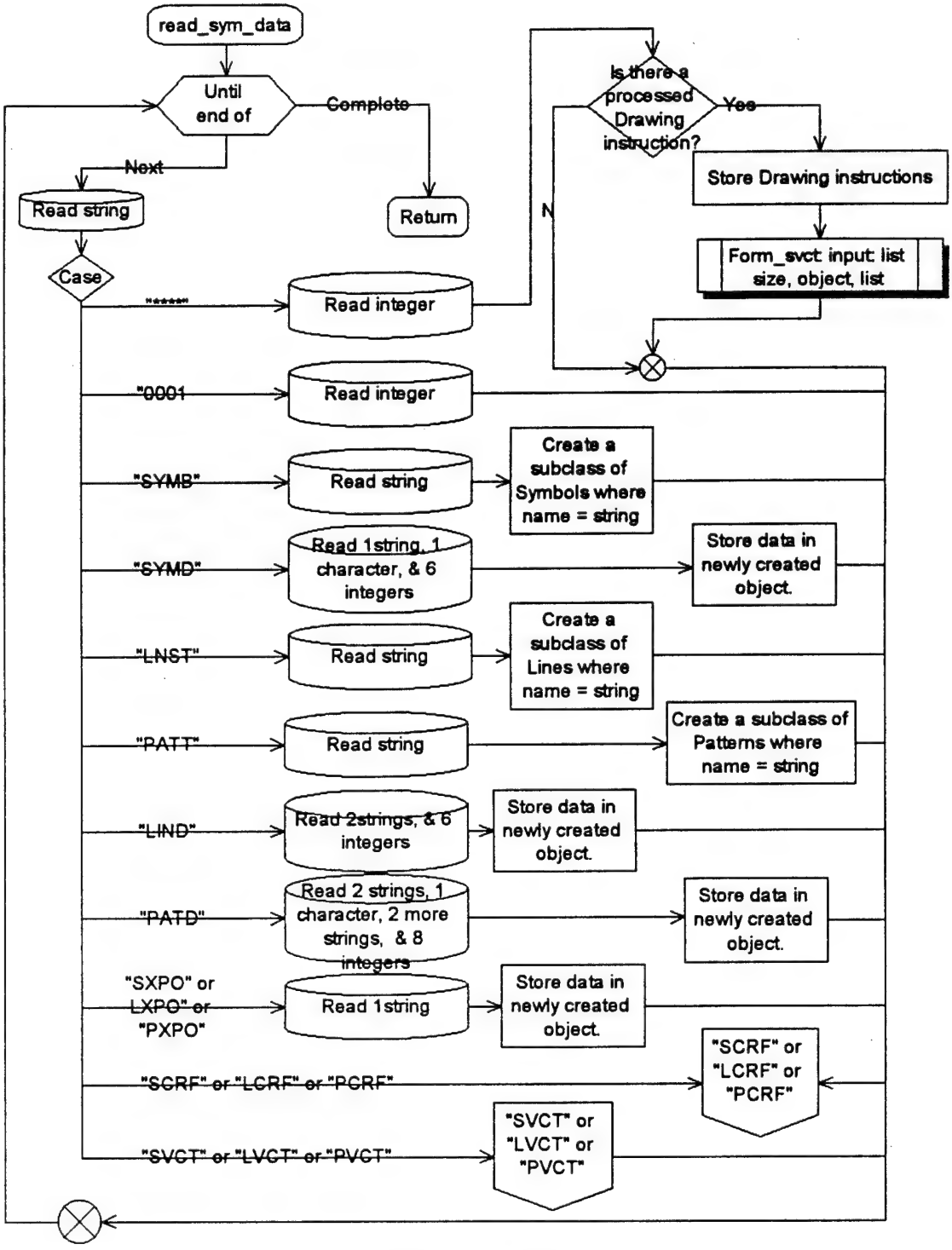


Previous View
figure 2.2.5.7

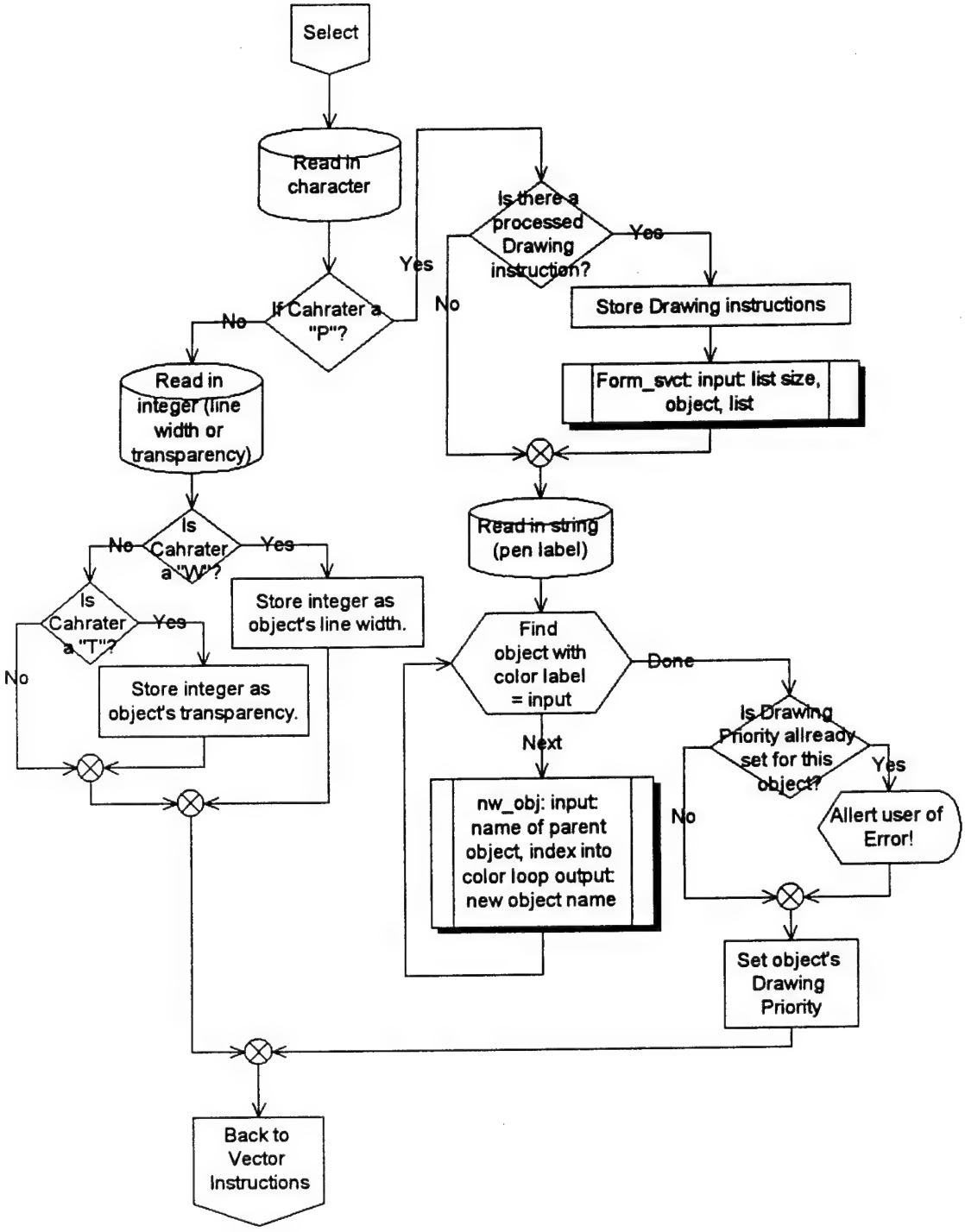
Initialize



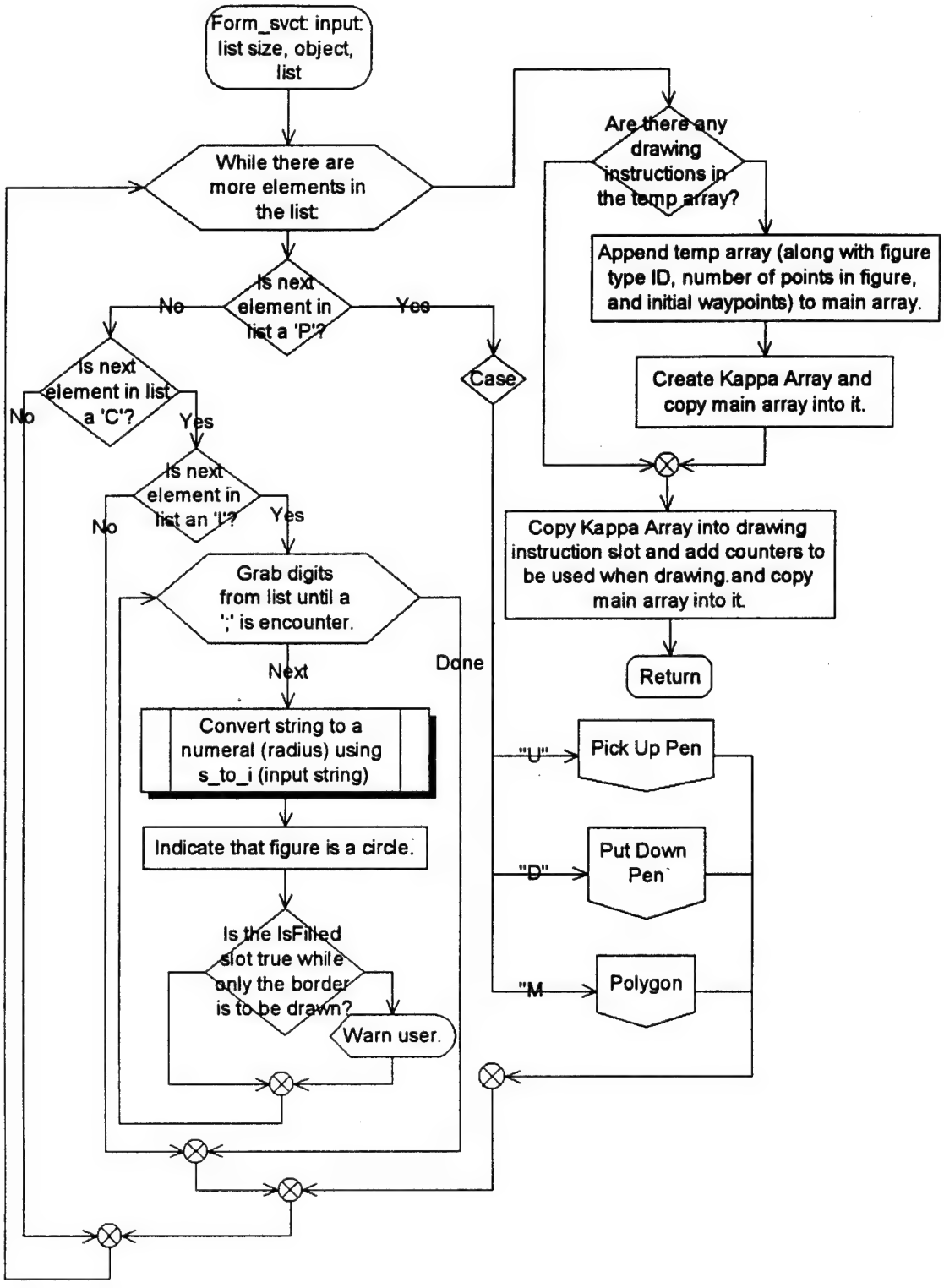
Load All
figure 2.2.6.1



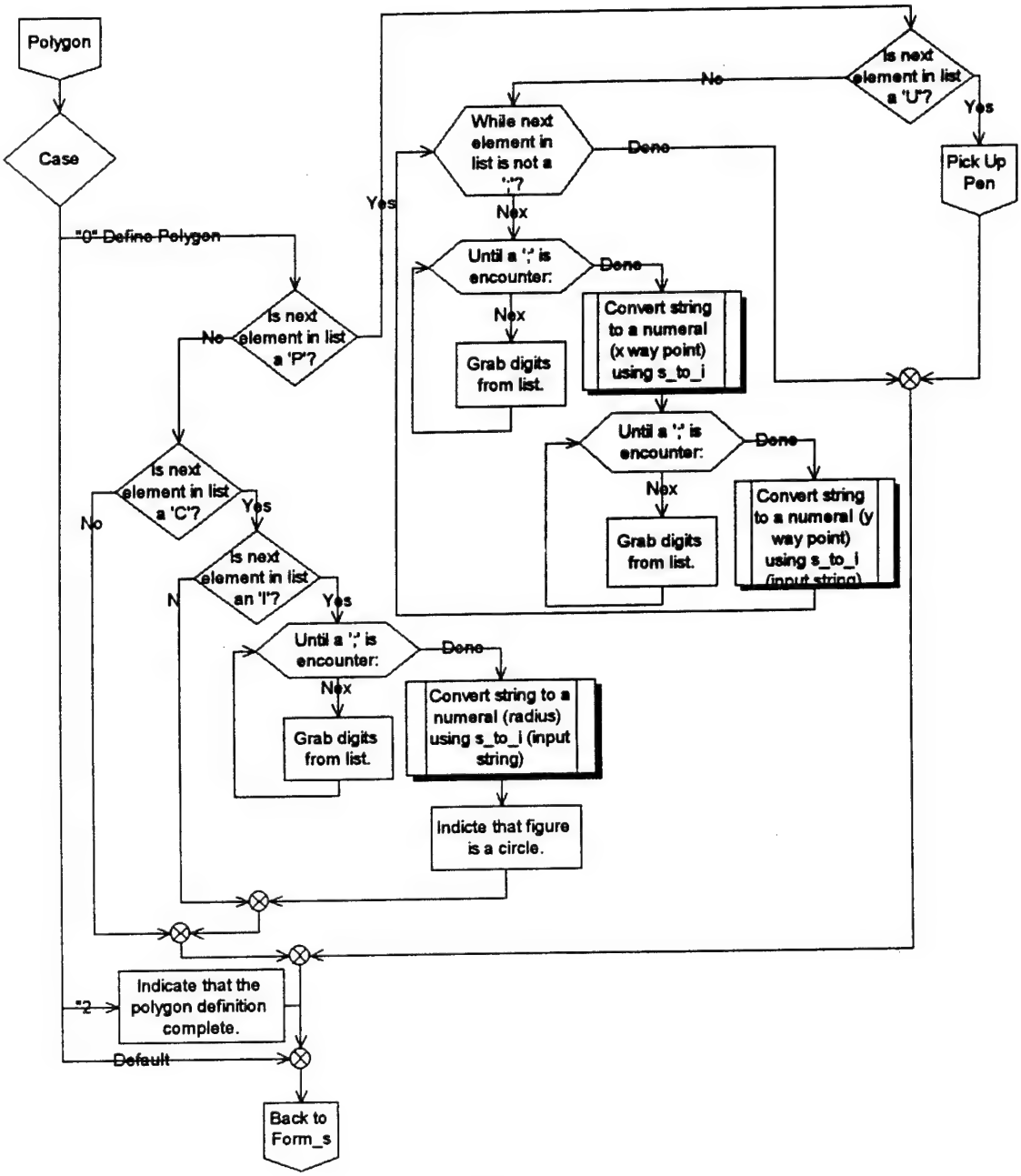
read_sym_data
figure 2.2.6.2.1.1



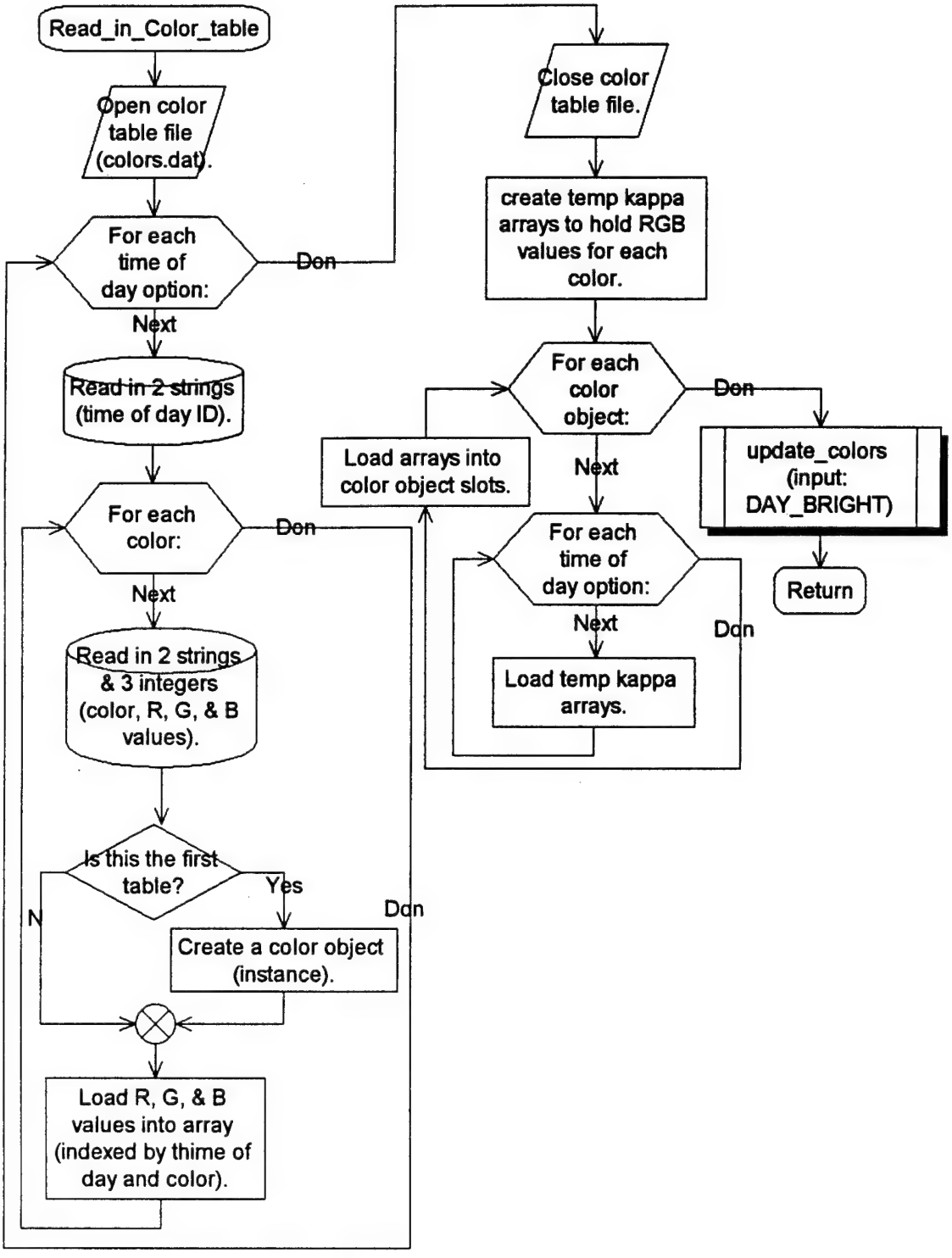
Select
figure 2.2.6.2.1.3.2



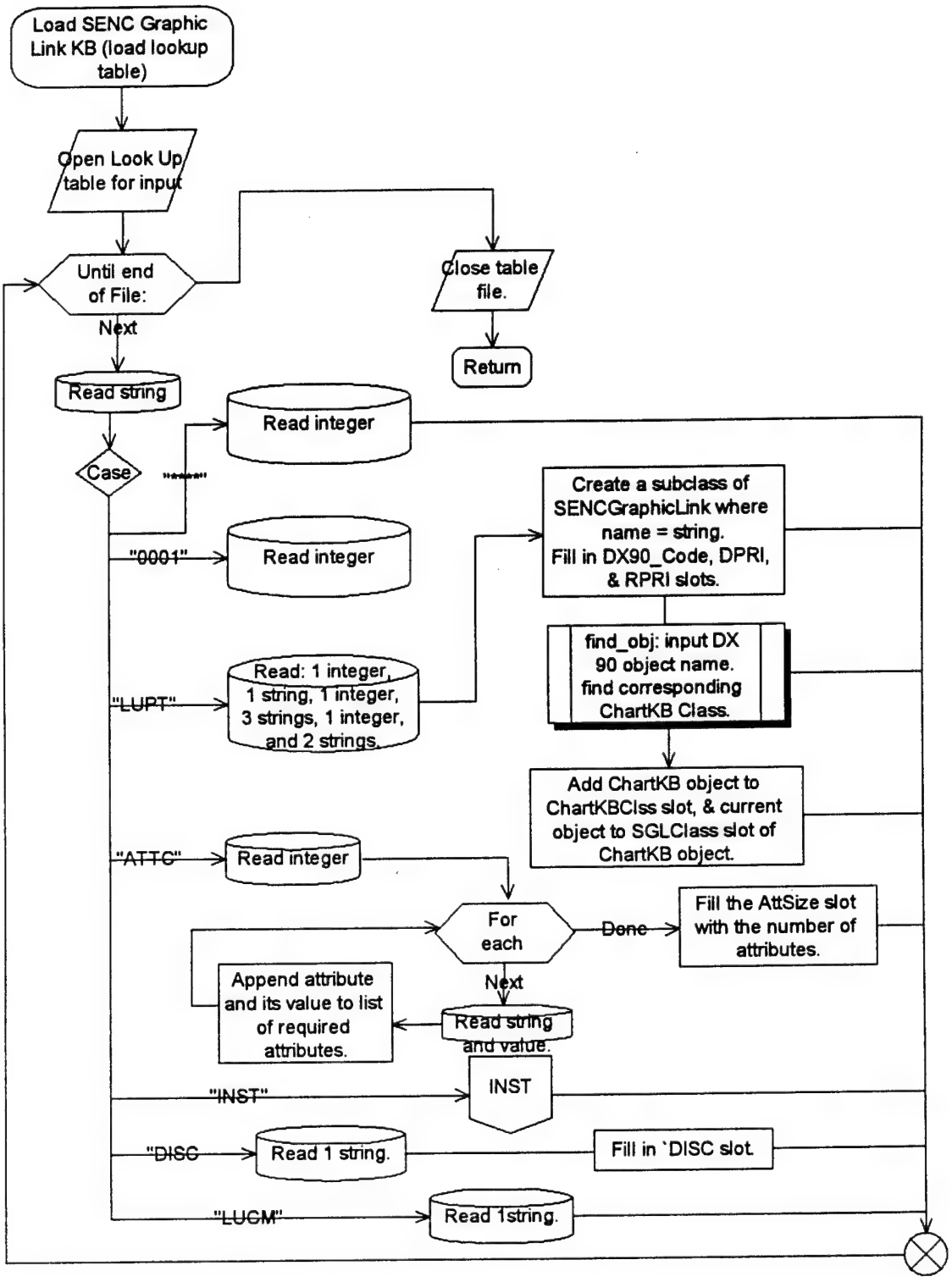
Form_svct
figure 2.2.6.2.2.1



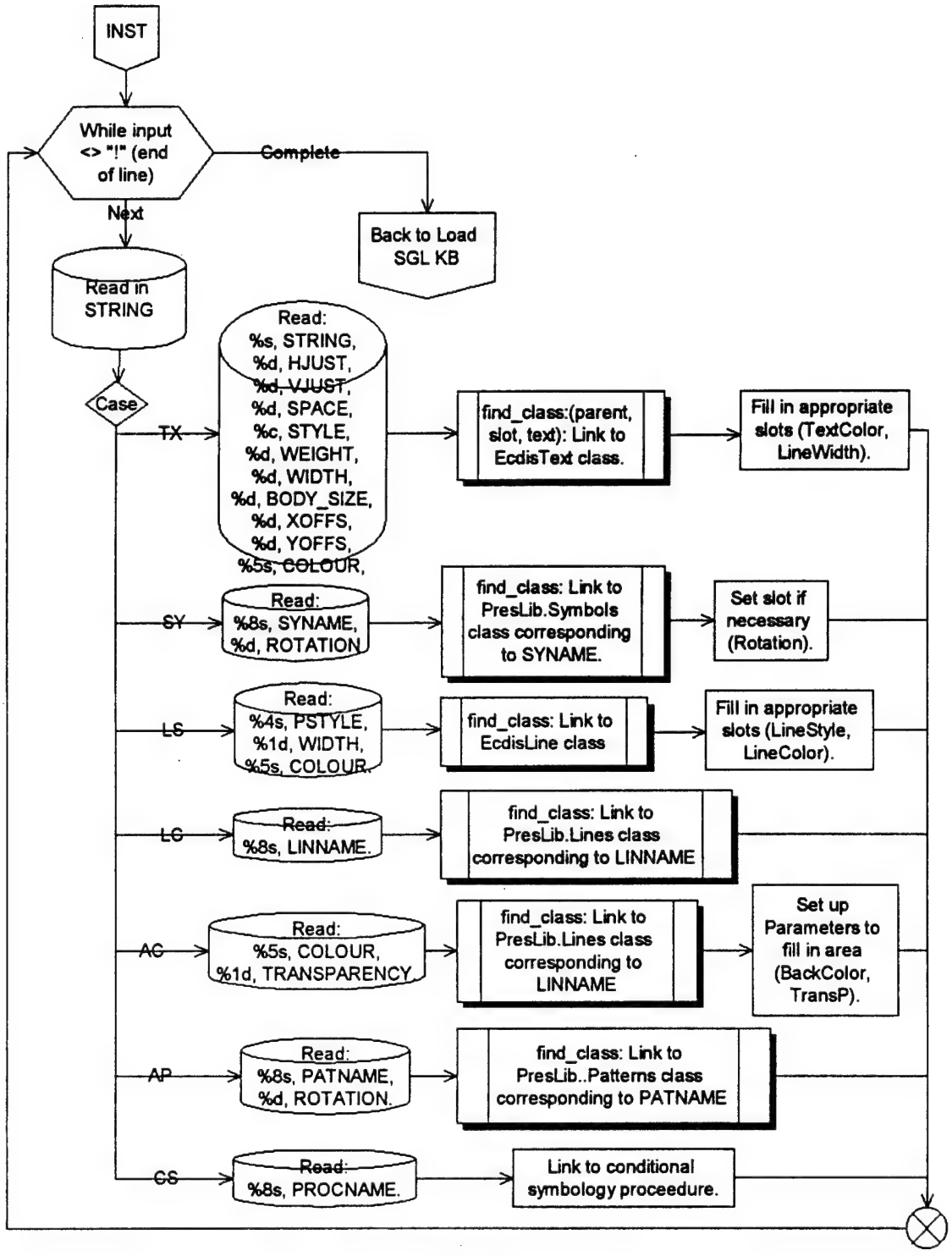
Polygon
figure 2.2.6.2.2.4



Read_in_Color_table
figure 2.2.6.3

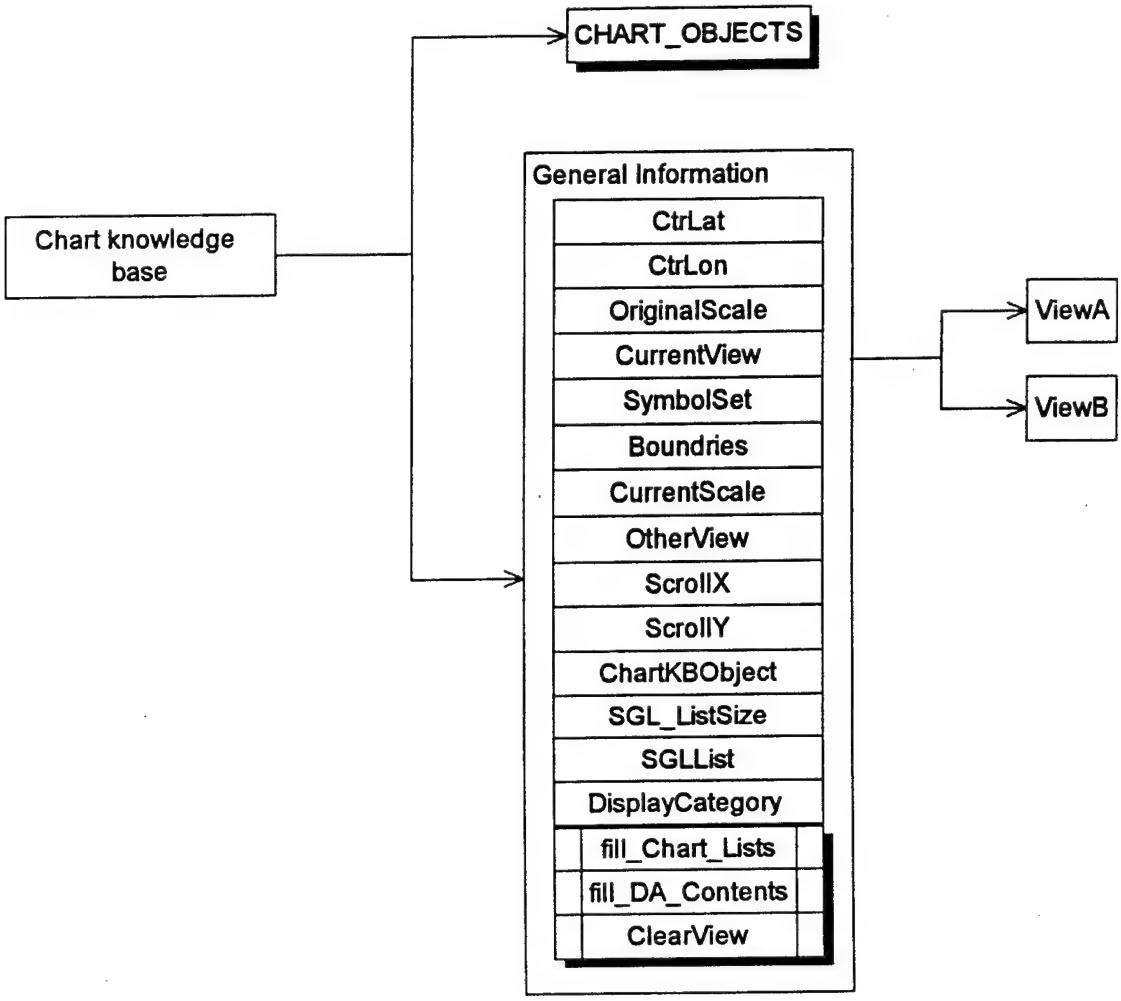


Load SENC Graphic Link KB
figure 2.2.6.4.1

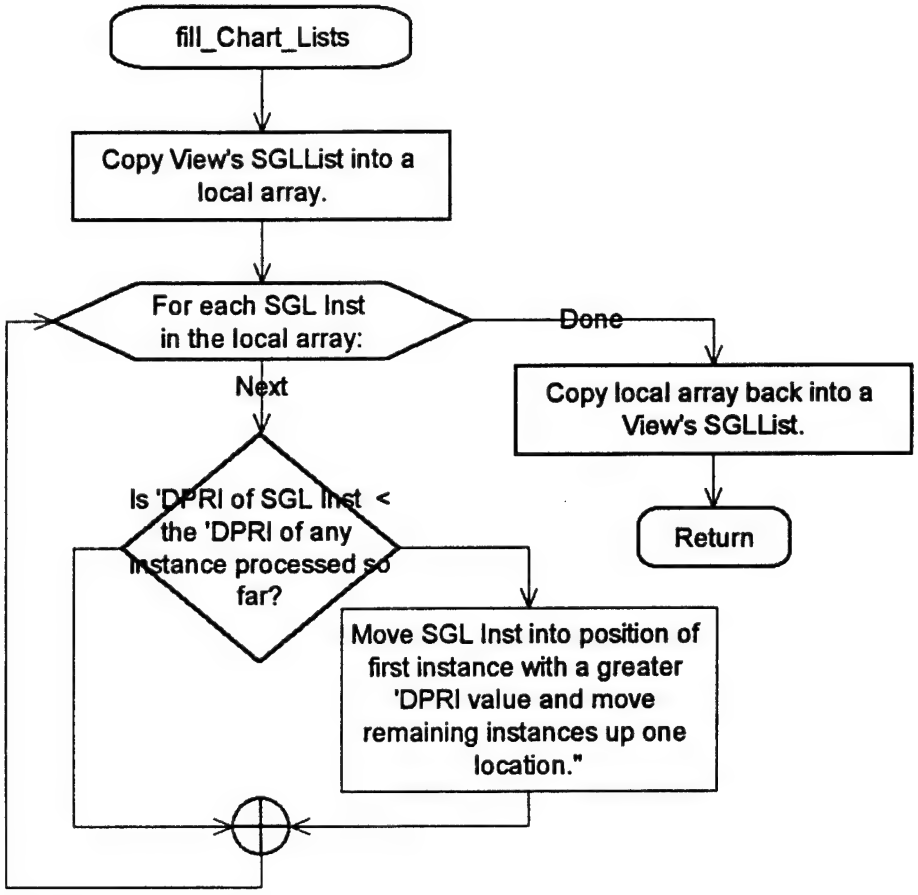


INST
figure 2.2.6.4.2

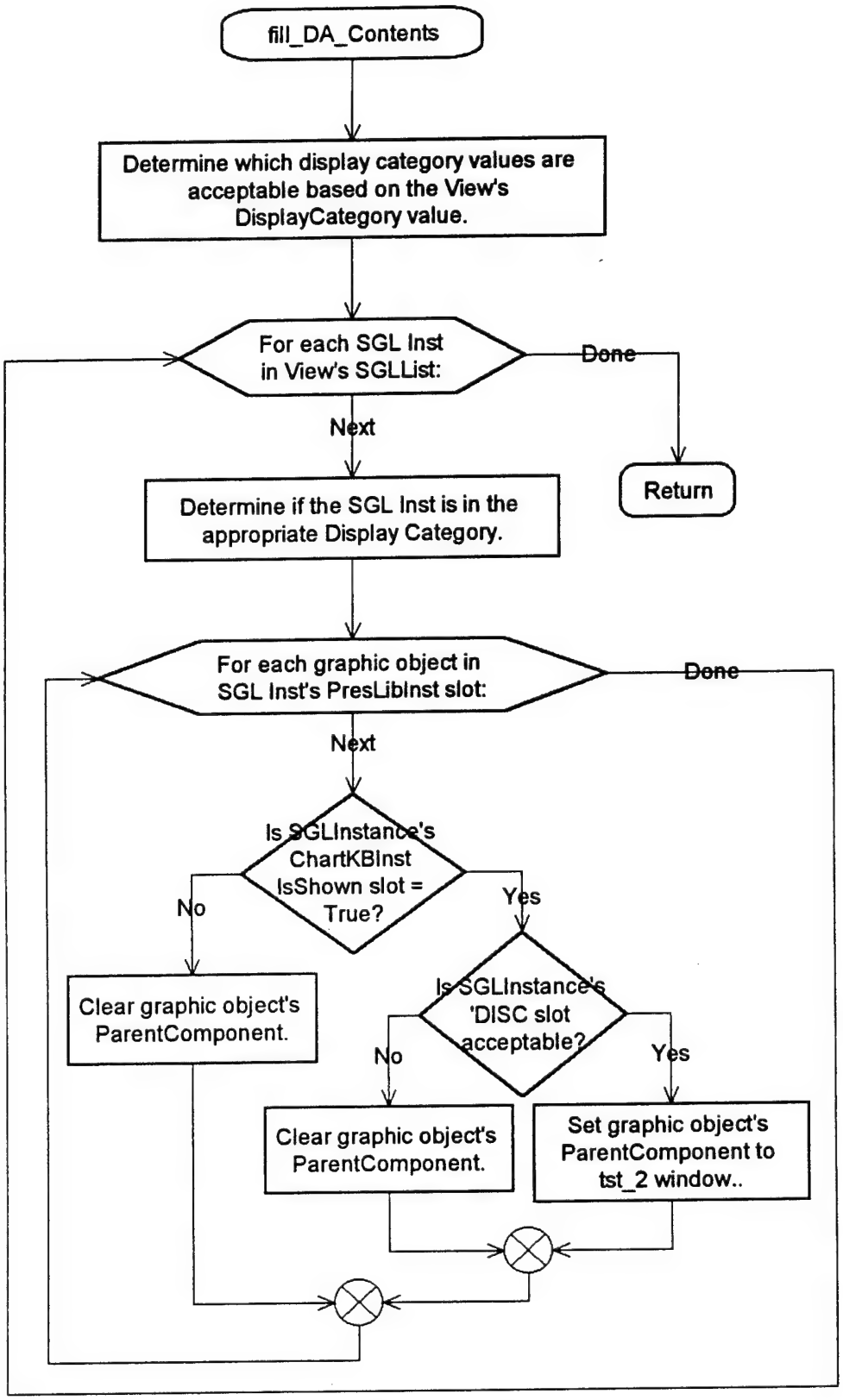
Chart Knowledge Base



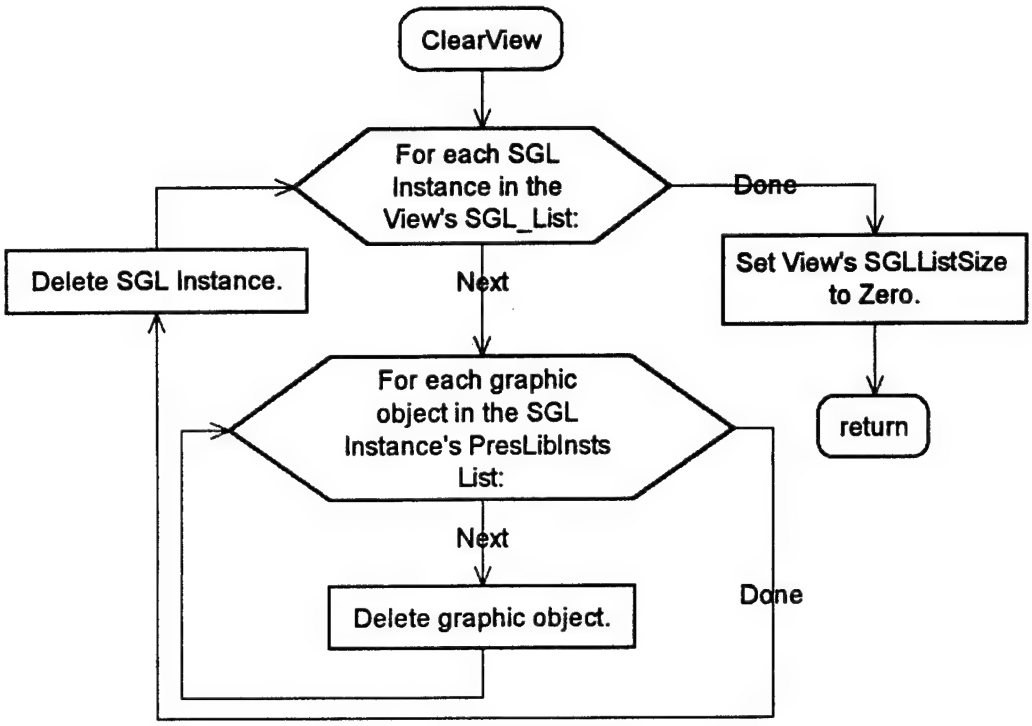
General Information
figure 2.3.1.1



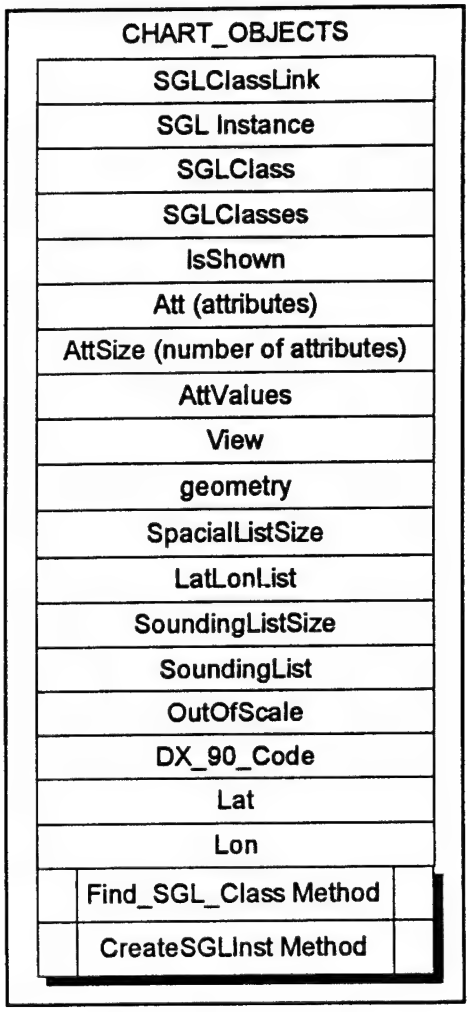
fill_Chart_Lists
figure 2.3.1.2



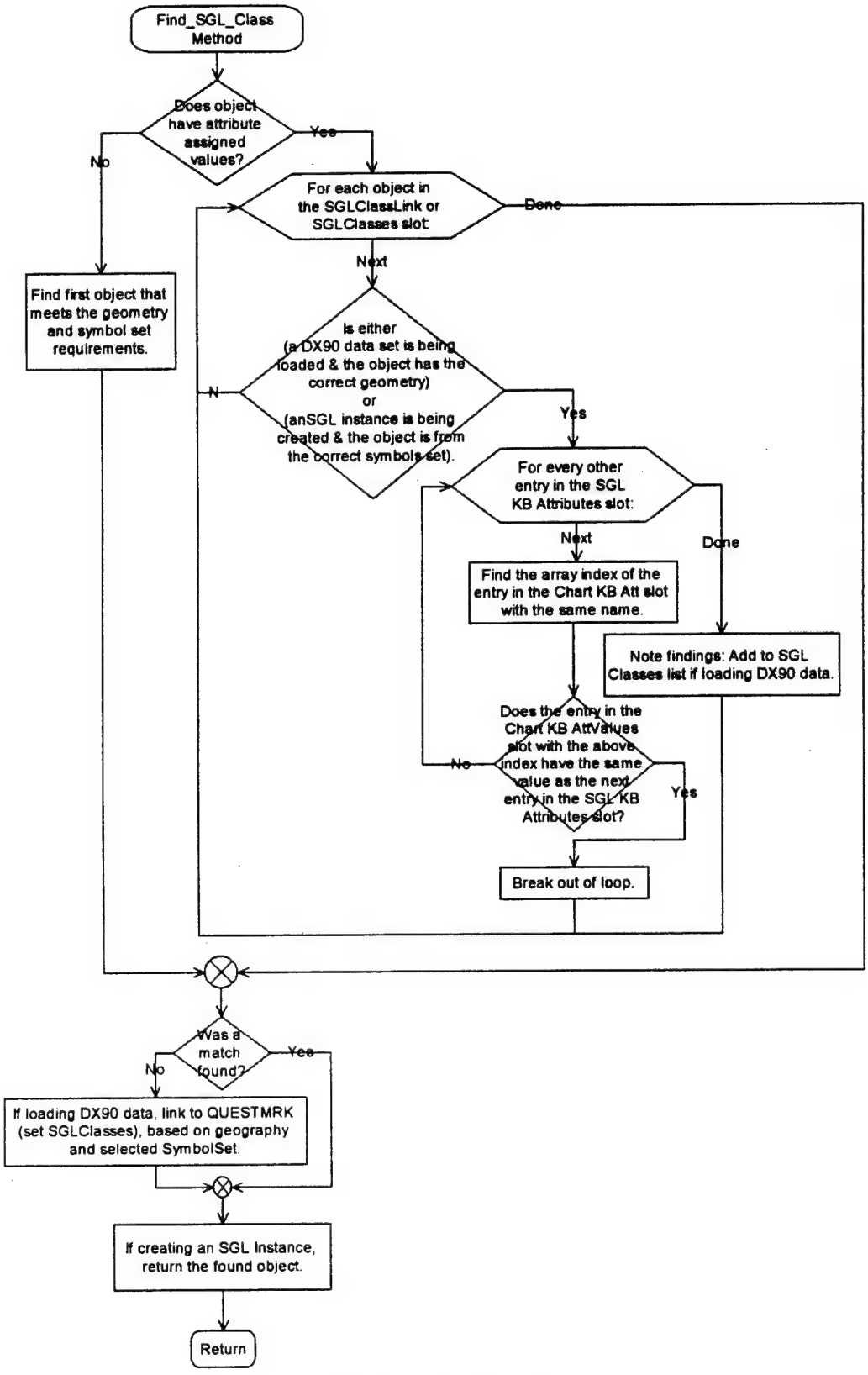
fill_DA_Contents
figure 2.3.1.3



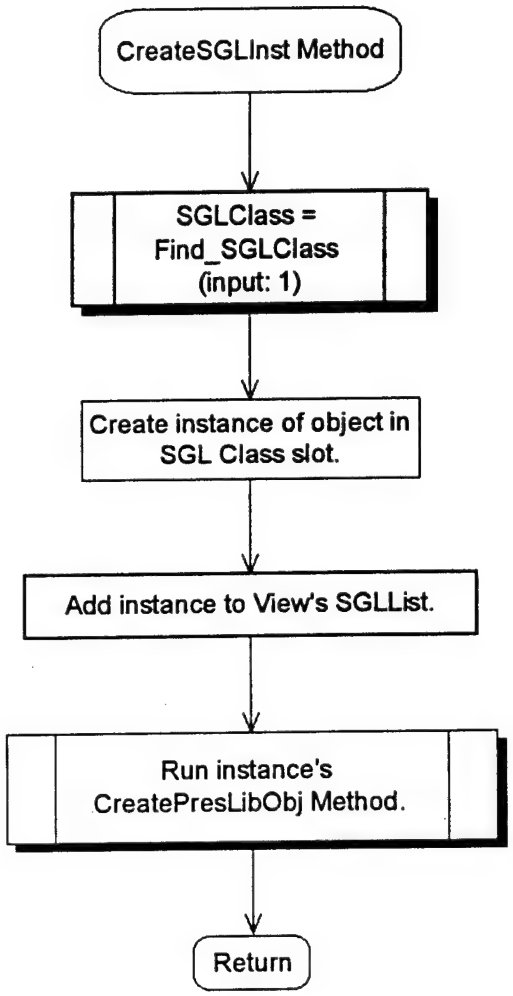
ClearView
figure 2.3.1.4



CHART_OBJECTS
figure 2.3.2.1



Find_SGL_Class
figure 2.3.2.2



CreateSGLInst Method
figure 2.3.2.3

SENCGraphicLink object knowledge Base

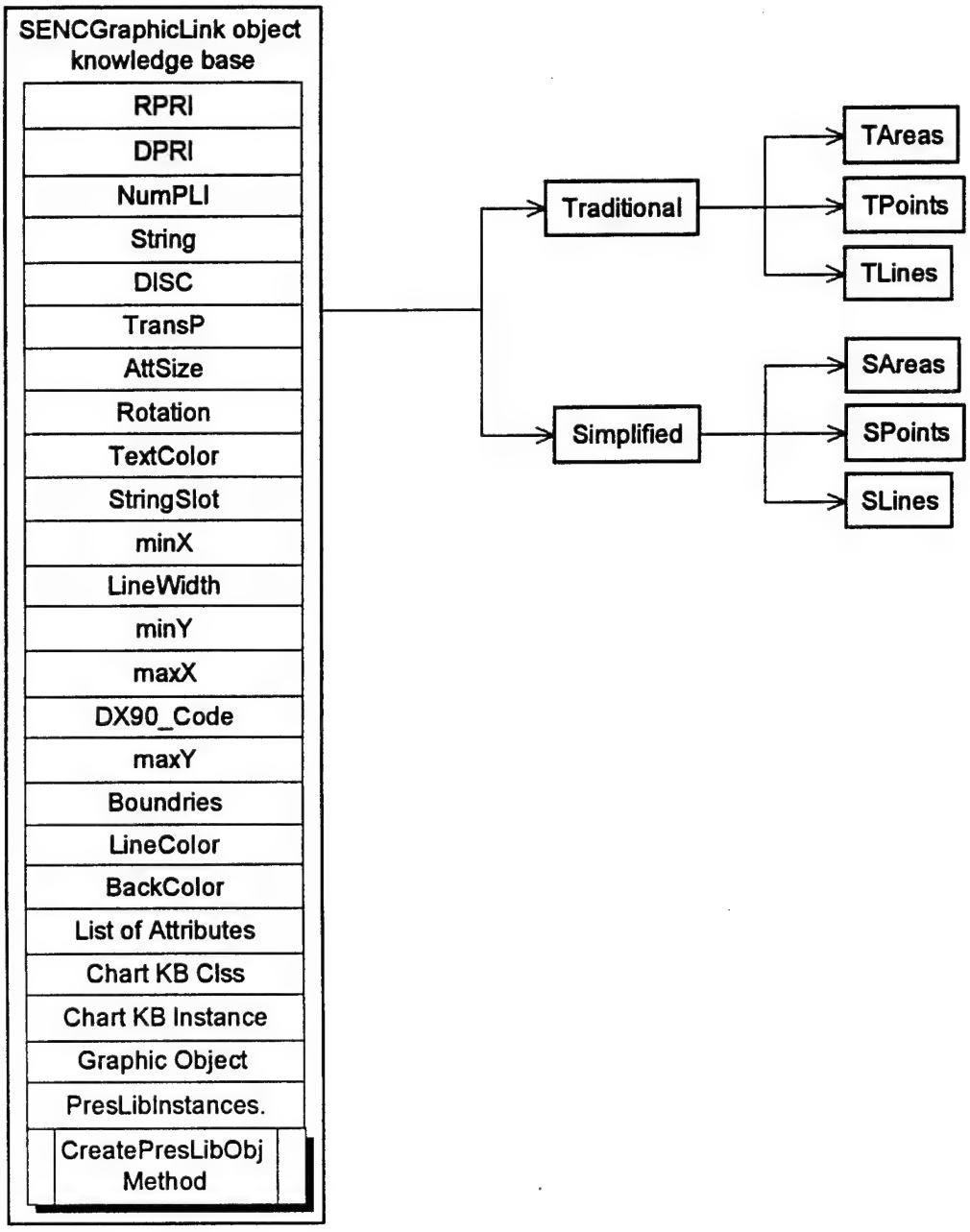
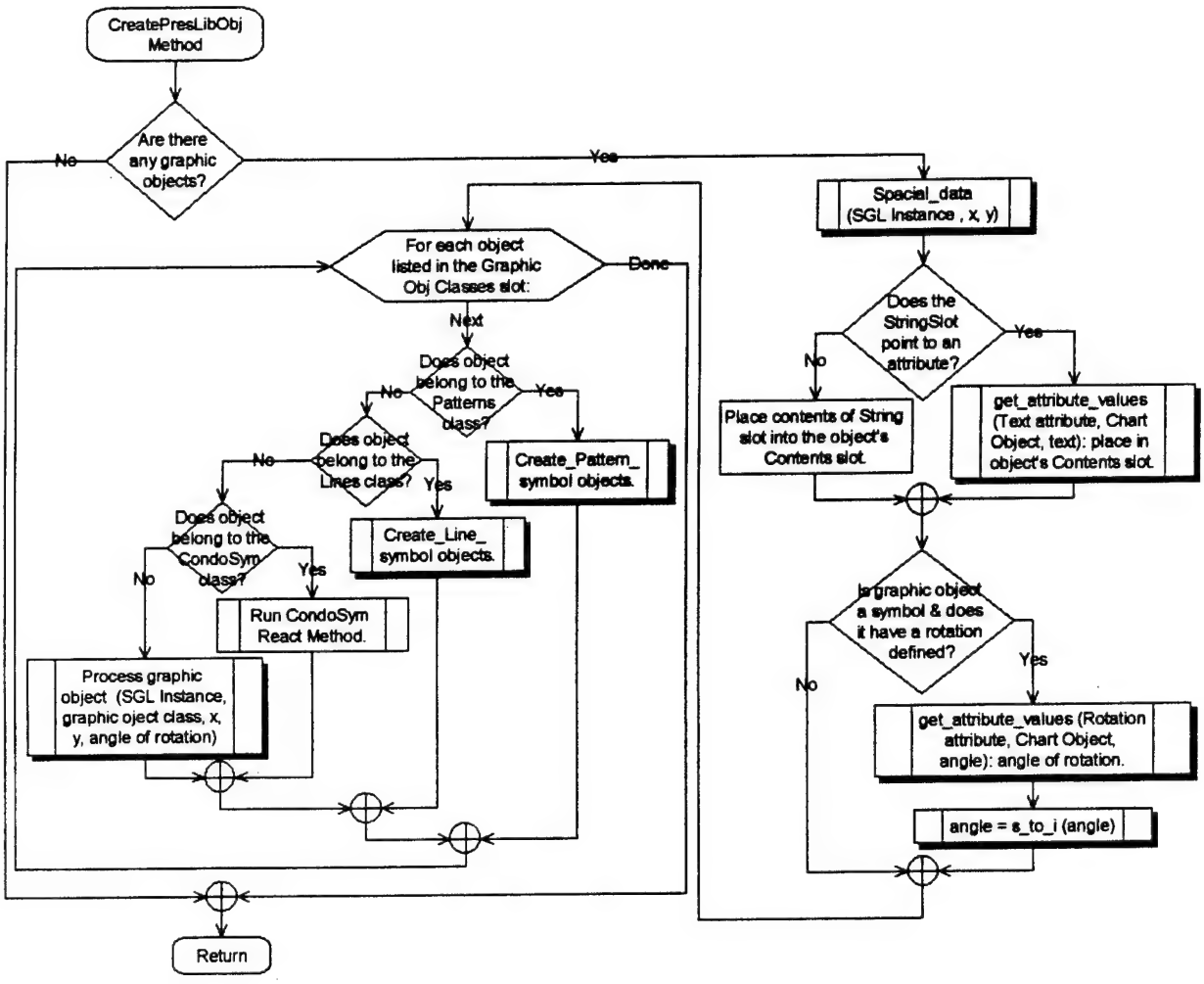


figure 2.4.1



CreatePresLibObj
figure 2.4.2.1

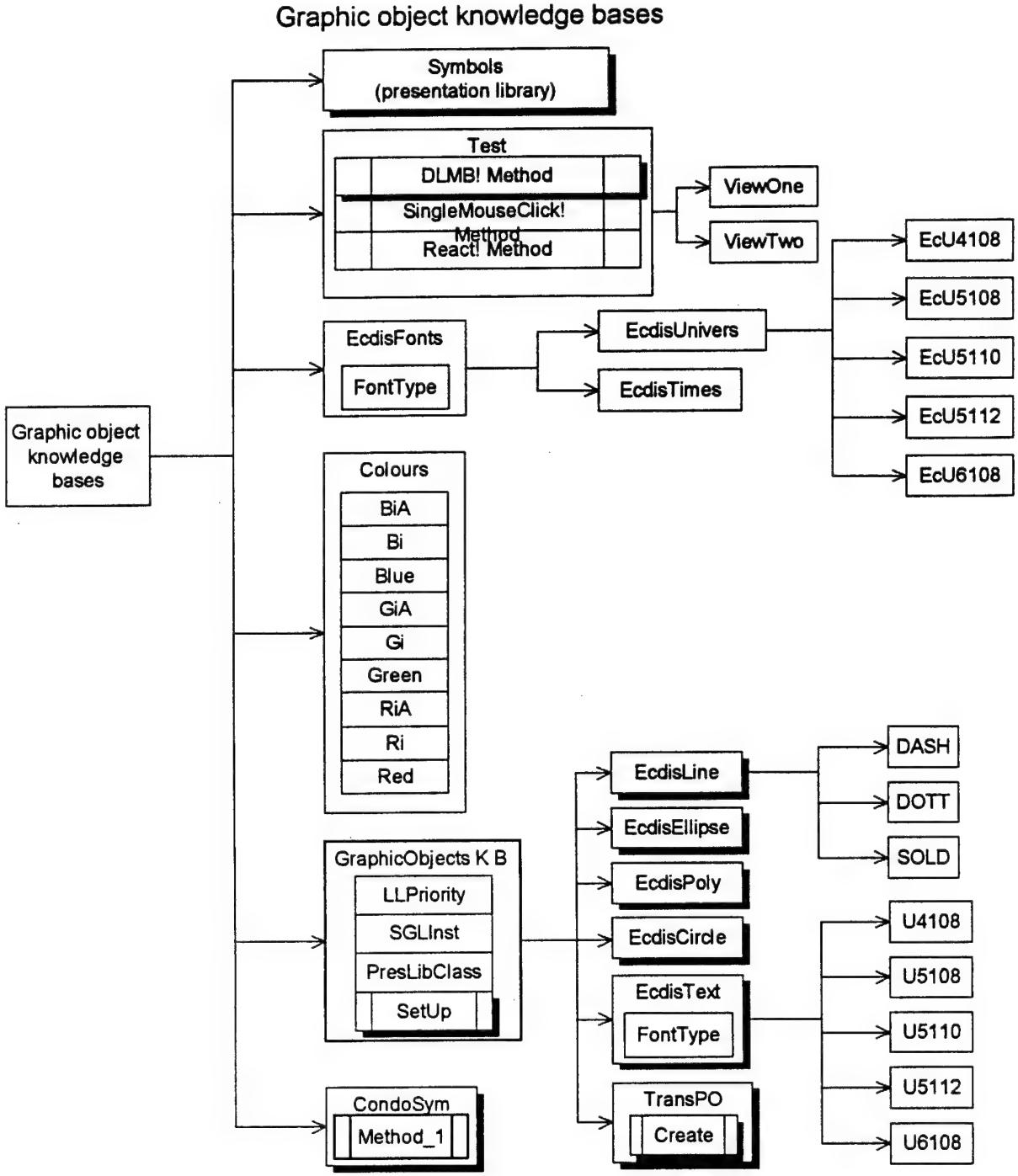
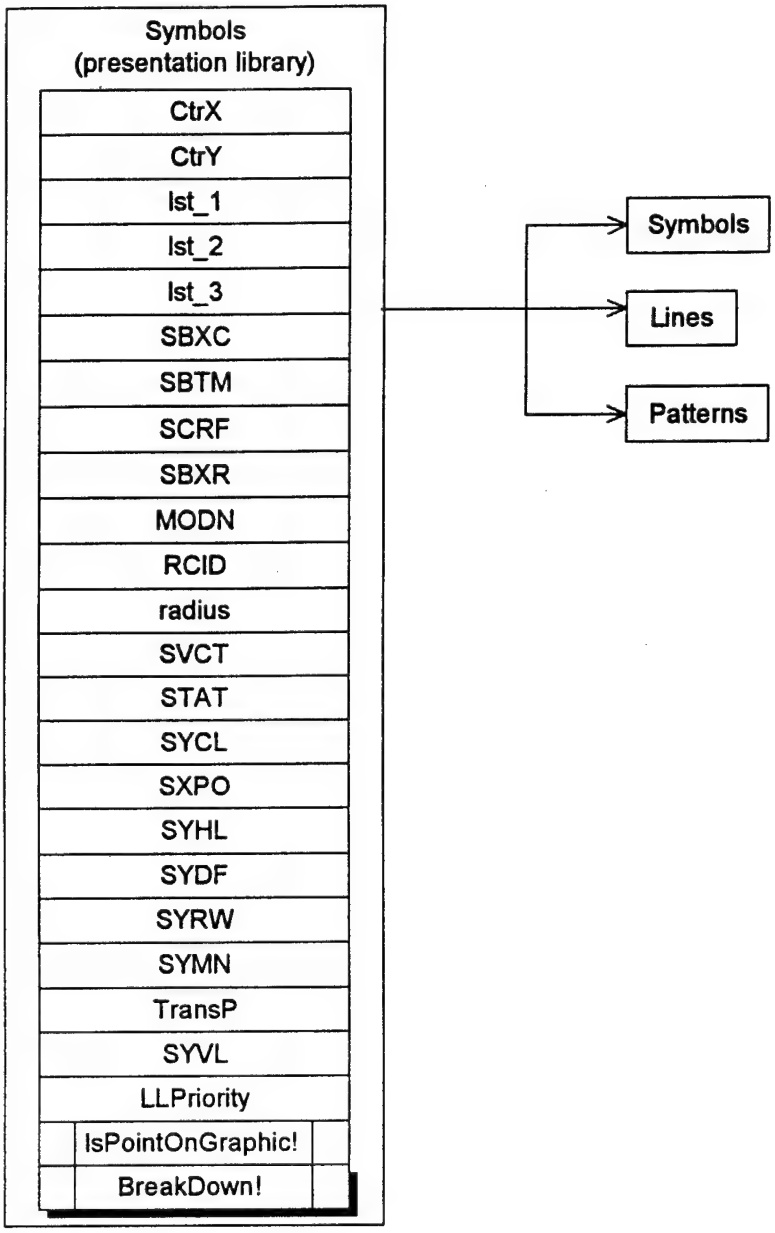
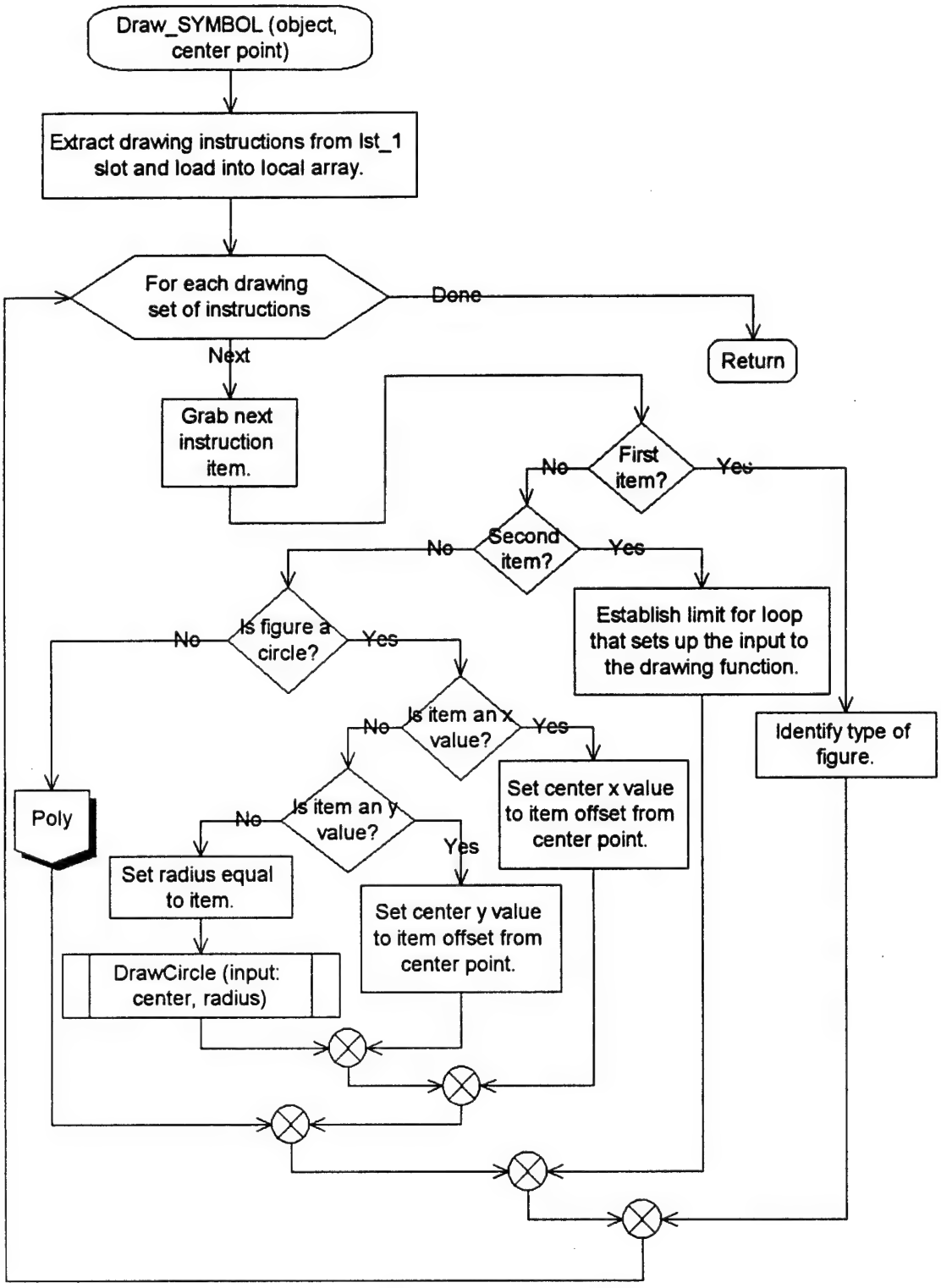

Graphic object knowledge bases
Symbols
(presentation library)
Test
DLMB! Method
SingleMouseClick!
Method
React! Method
ViewOne
ViewTwo
EcU4108
EcU5108
EcU5110
EcU5112
EcU6108
EcdisFonts
FontType
EcdisUnivers
EcdisTimes
Graphic object knowledge bases
Colours
BiA
Bi
Blue
GiA
Gi
Green
RiA
Ri
Red
GraphicObjects K B
LLPriority
SGLInst
PresLibClass
SetUp
CondoSym
Method_1
EcdisLine
EcdisEllipse
EcdisPoly
EcdisCircle
EcdisText
FontType
TransPO
Create
DASH
DOTT
SOLD
U4108
U5108
U5110
U5112
U6108

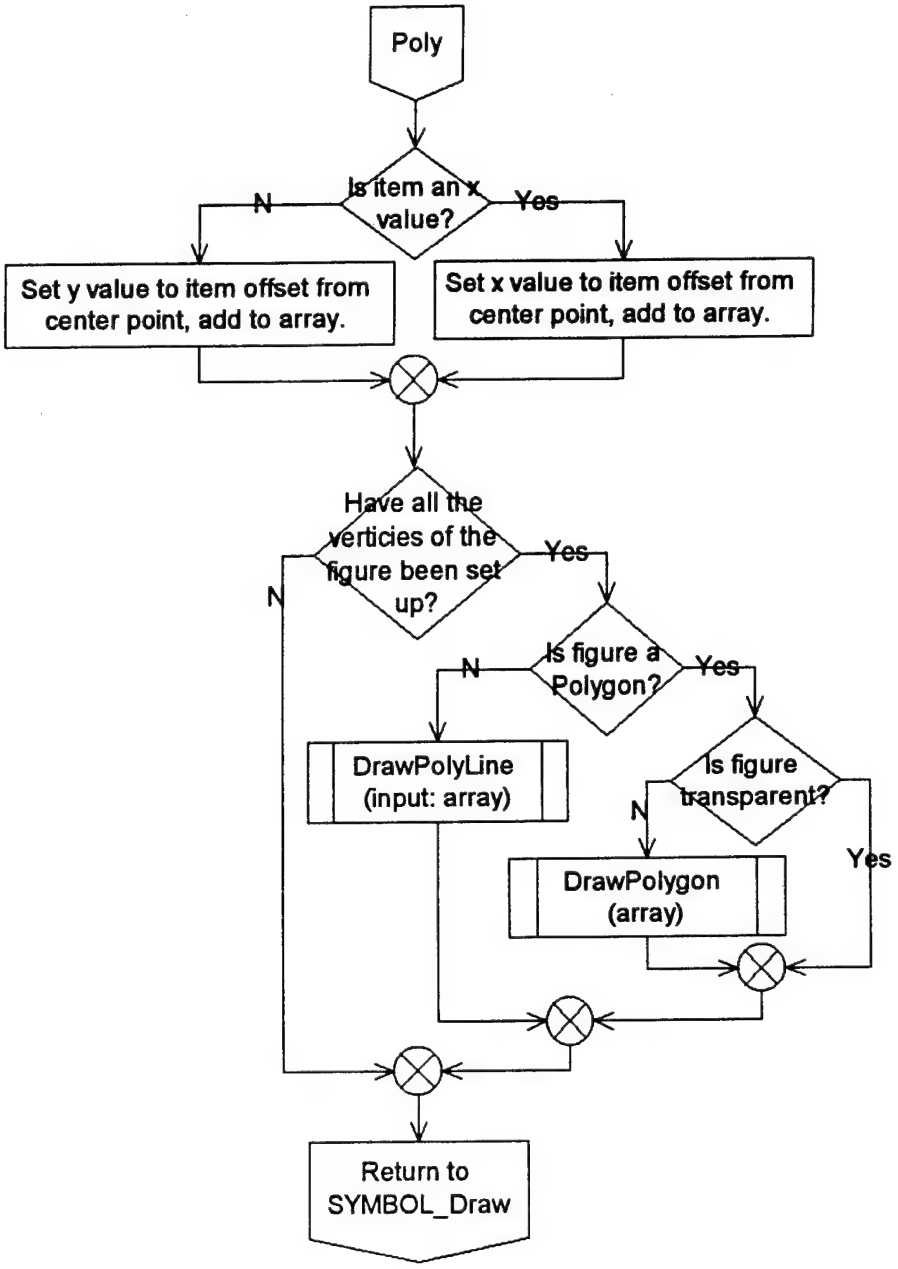
figure 2.5.1



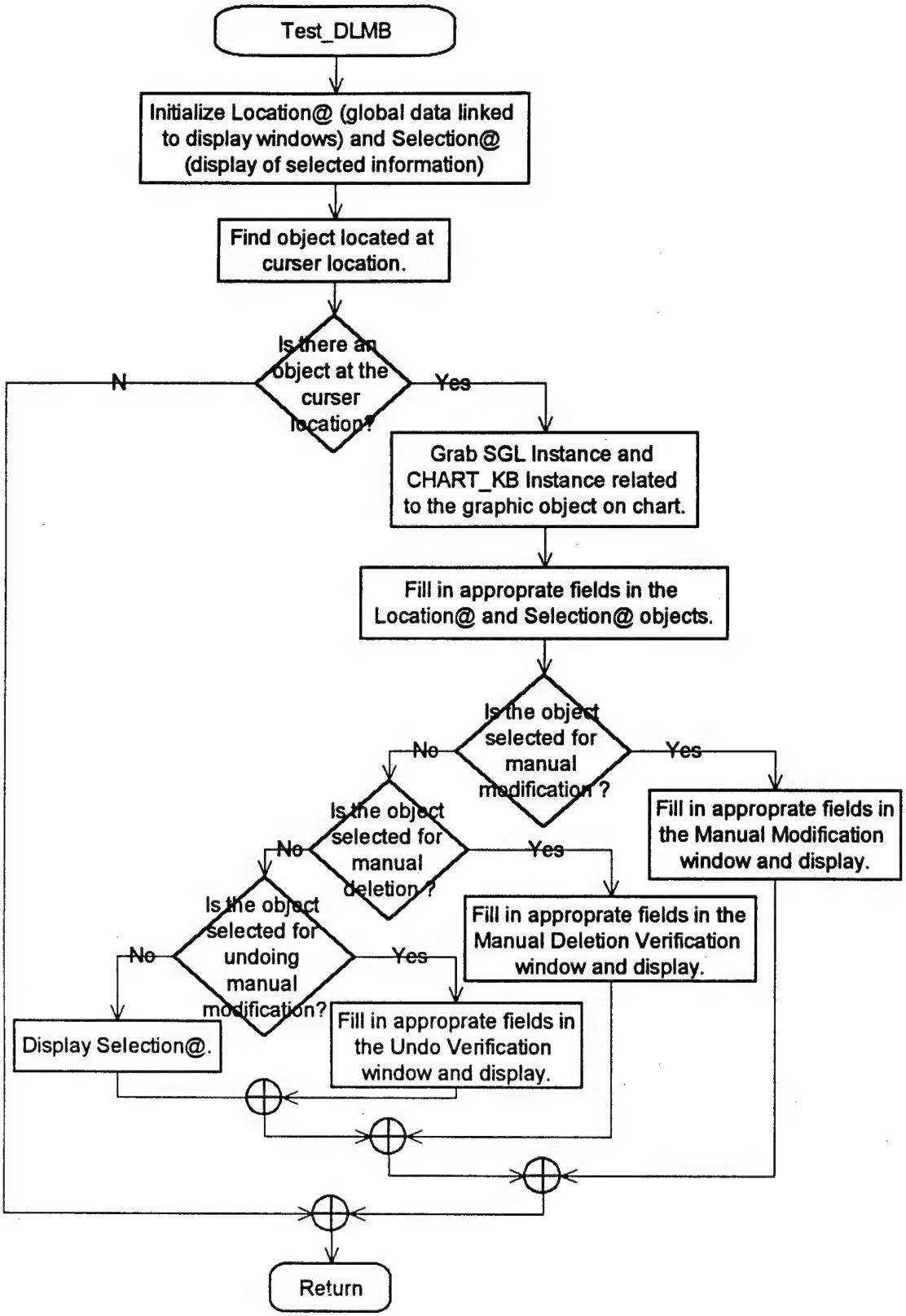
Symbols knowledge base
figure 2.5.2.1



Draw
figure 2.5.2.2



Poly
figure 2.5.2.3



Test_DLMB
figure 2.5.3

SENC Presentation Software

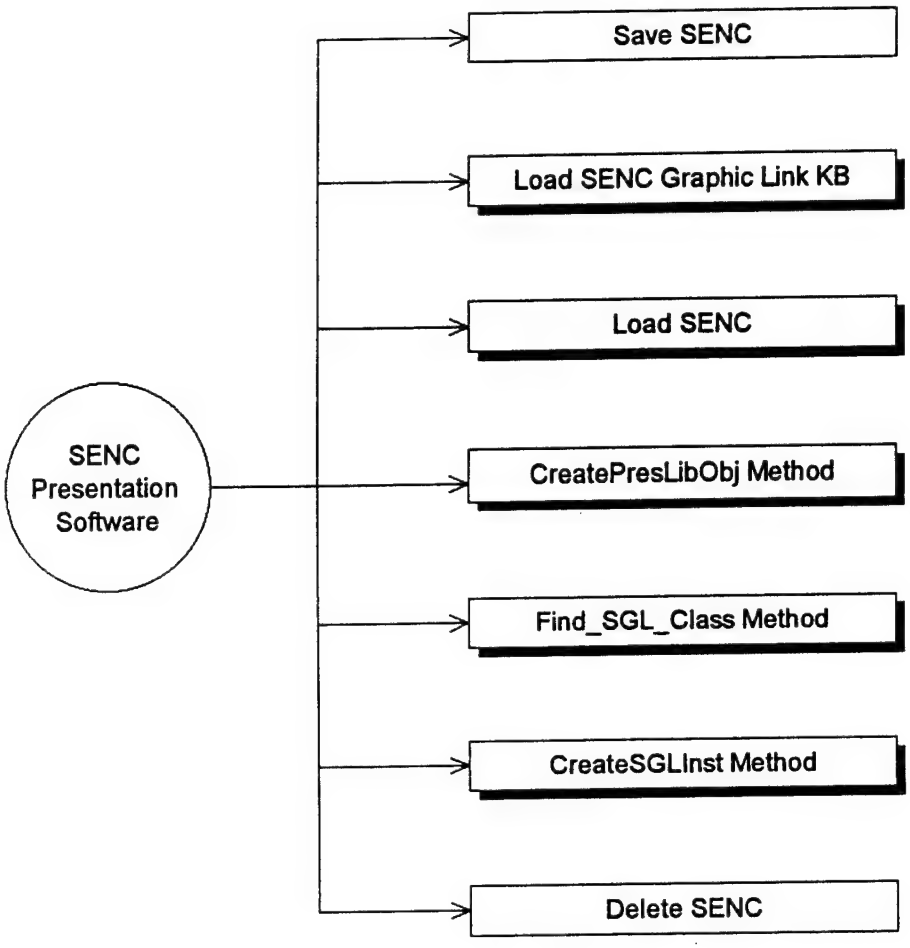


figure 2.6.1

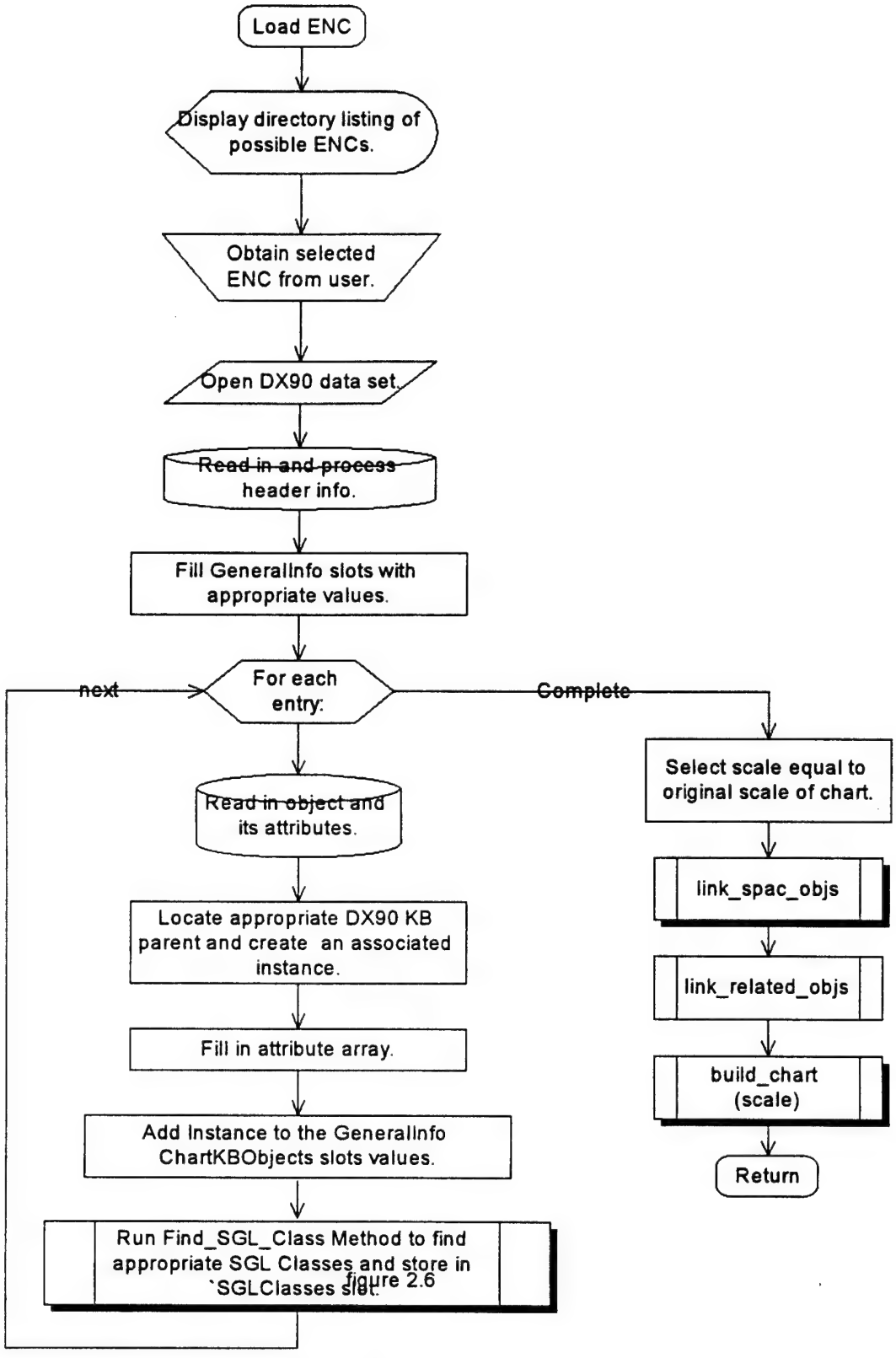
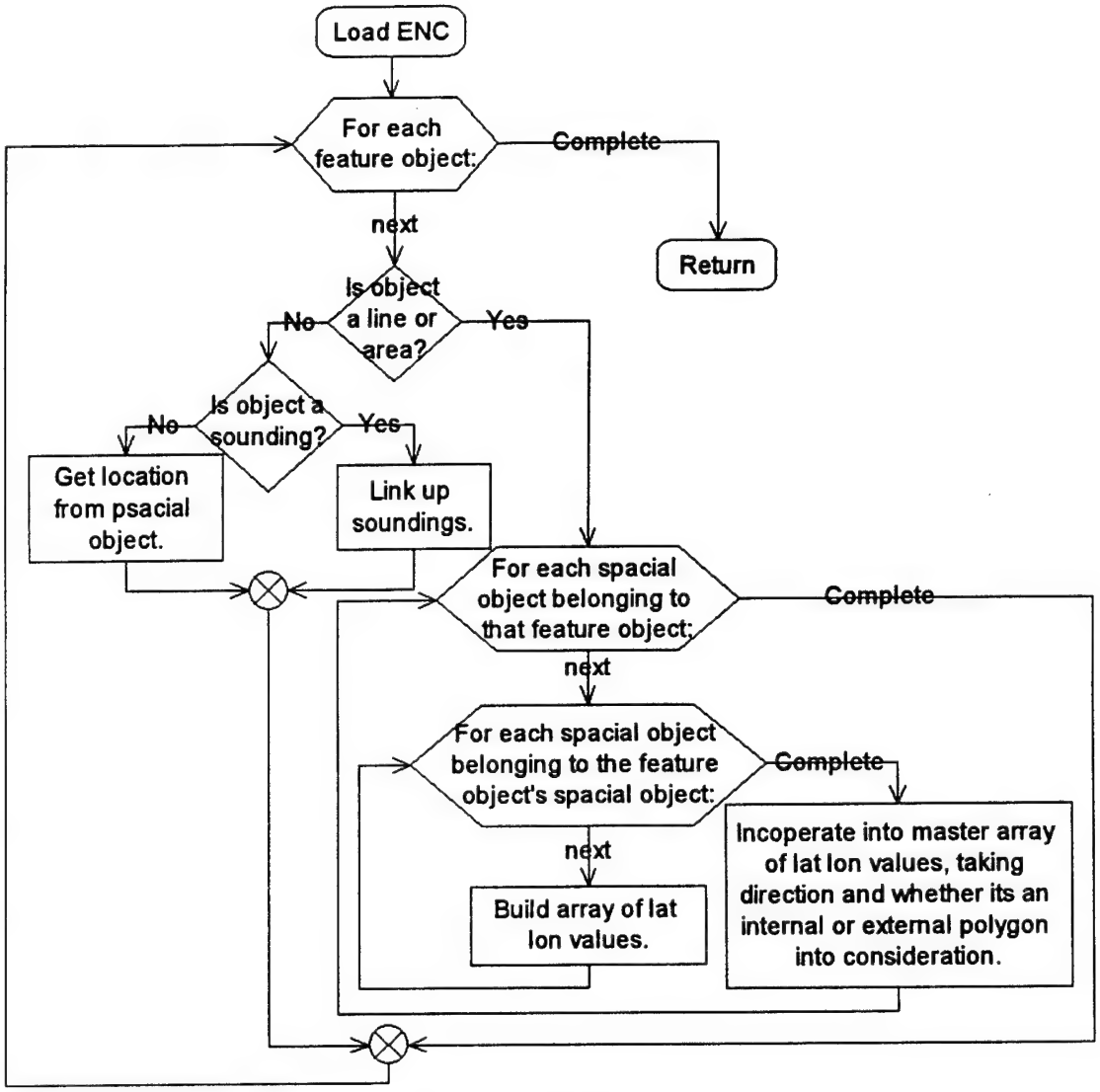
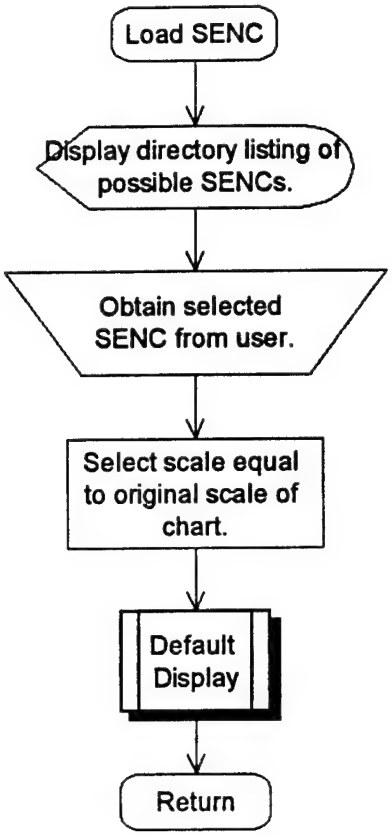


figure 2.6

Load SENC Graphic Link KB
figure 2.6.2.1



Link Spacial Objects
figure 2.6.2.2



Load SENC
figure 2.6.3

Manual Updating

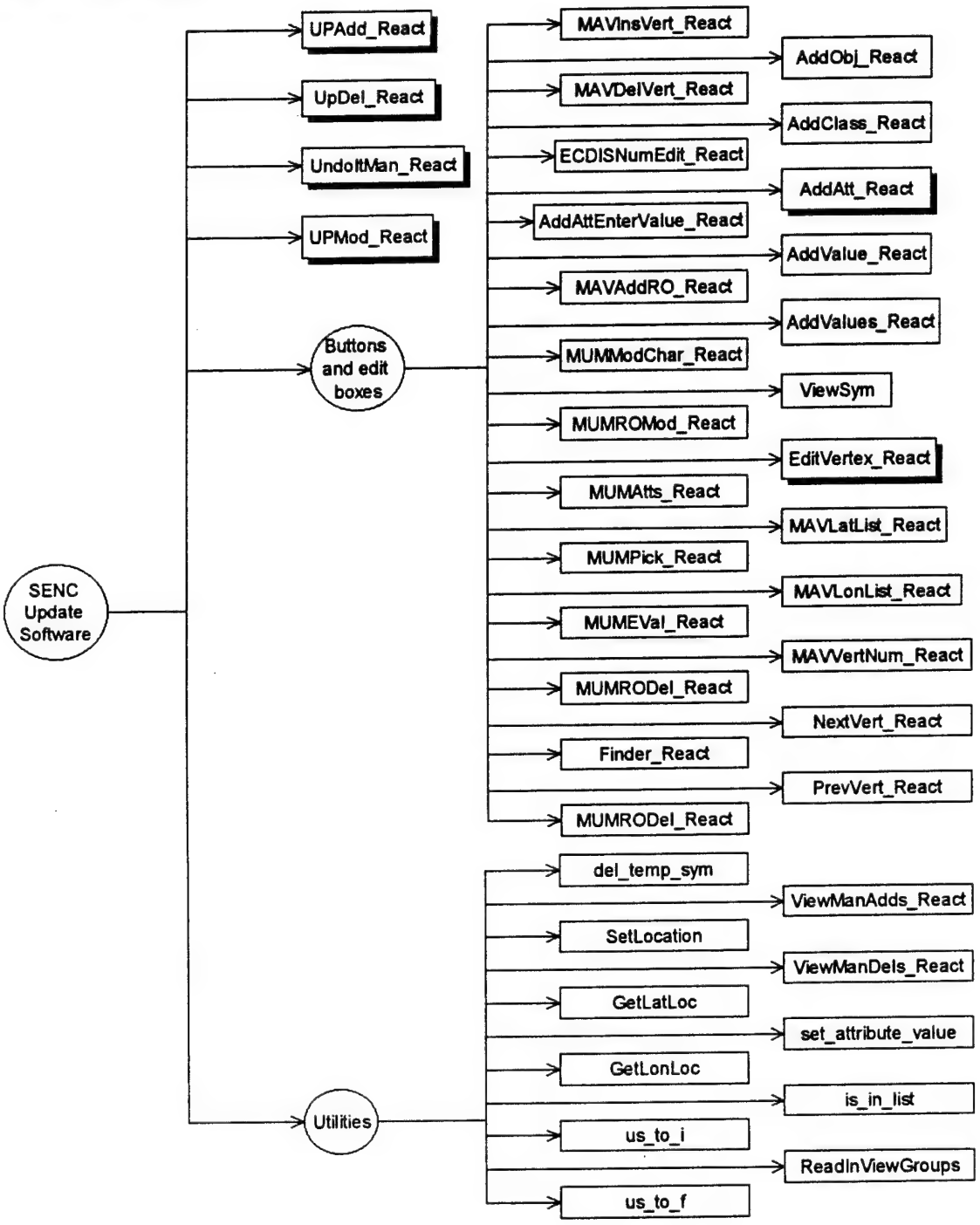
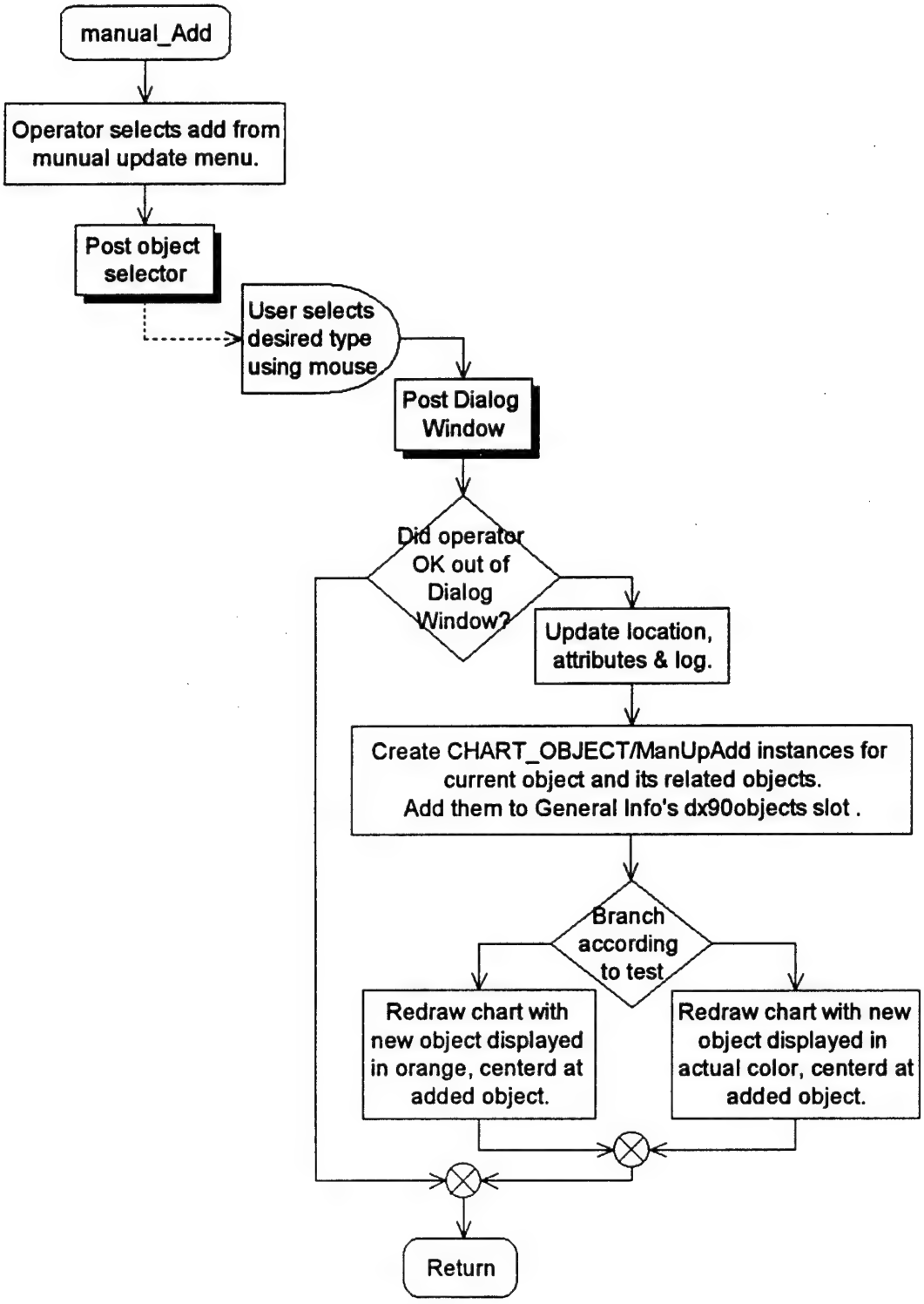
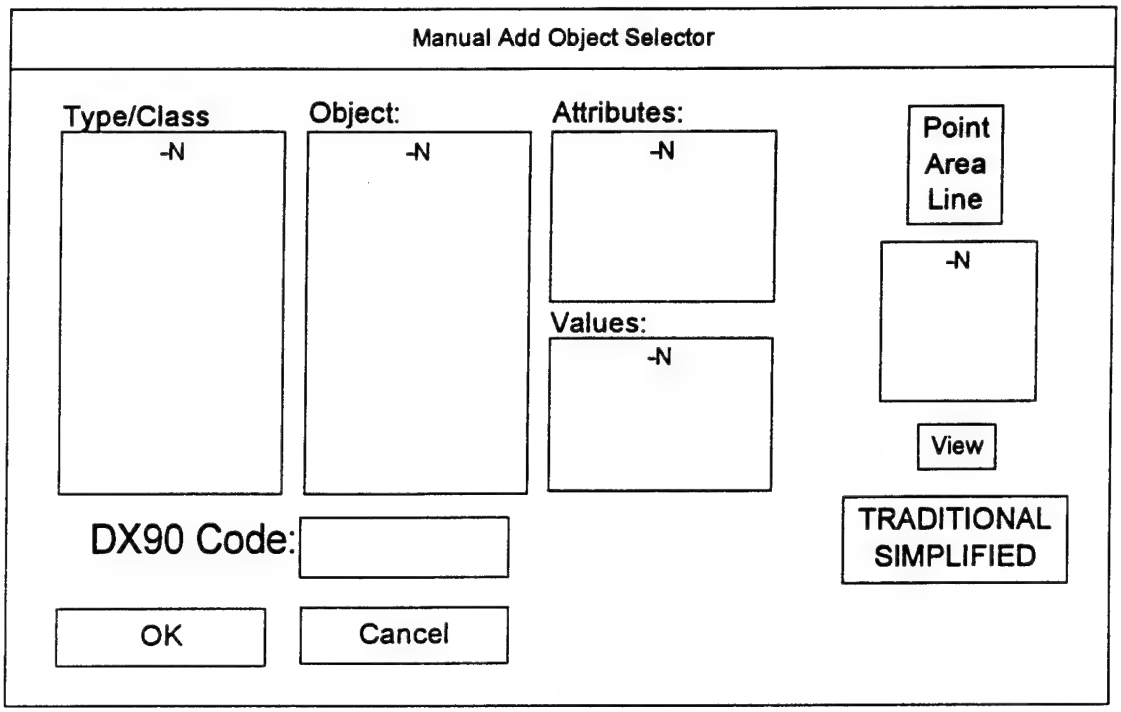


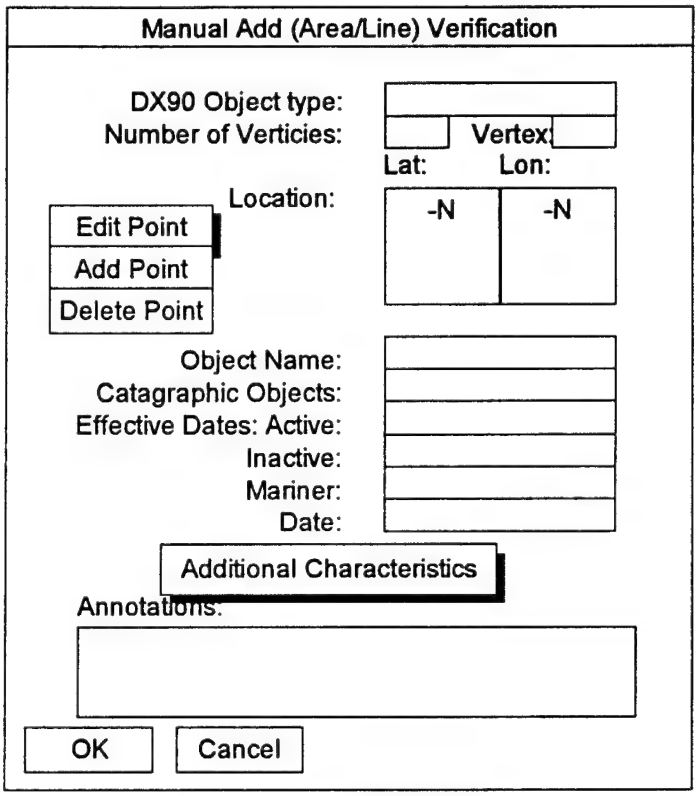
figure 2.1.1



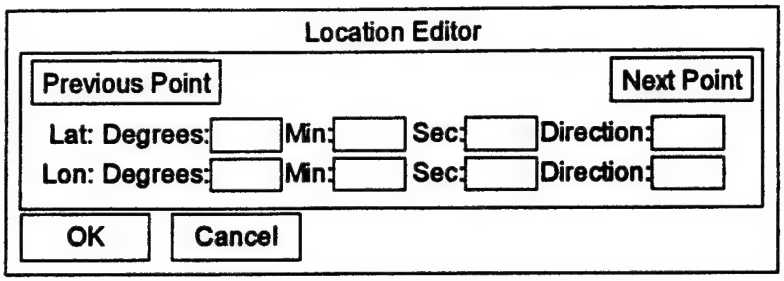
UP_Add_React
figure 2.7.2.1



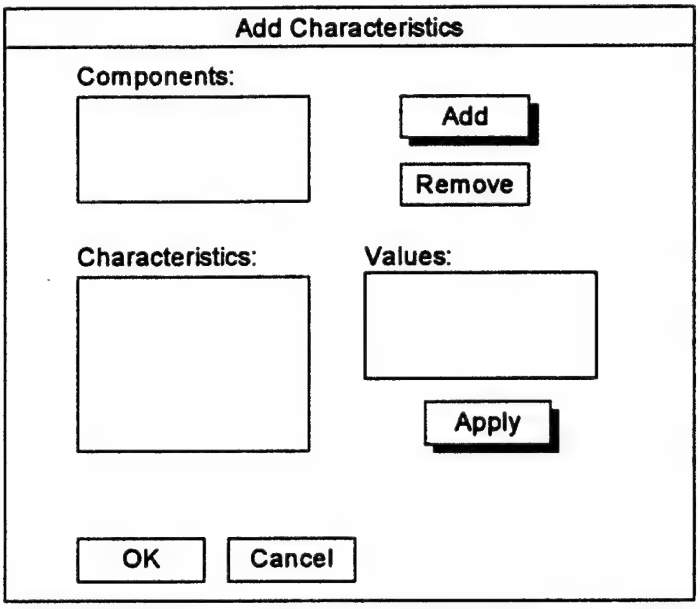
Object Selector
figure 2.7.2.2



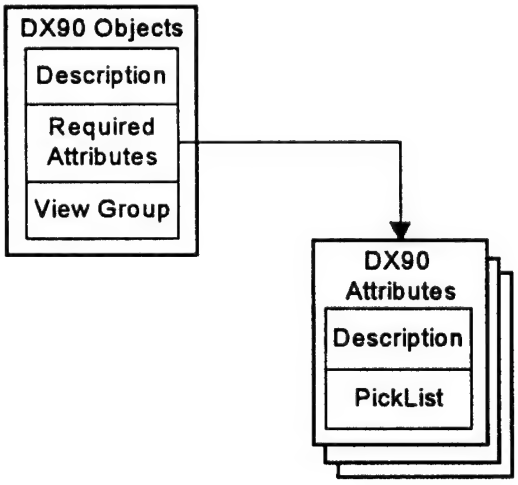
ManAdd Verification
figure 2.7.2.3.1



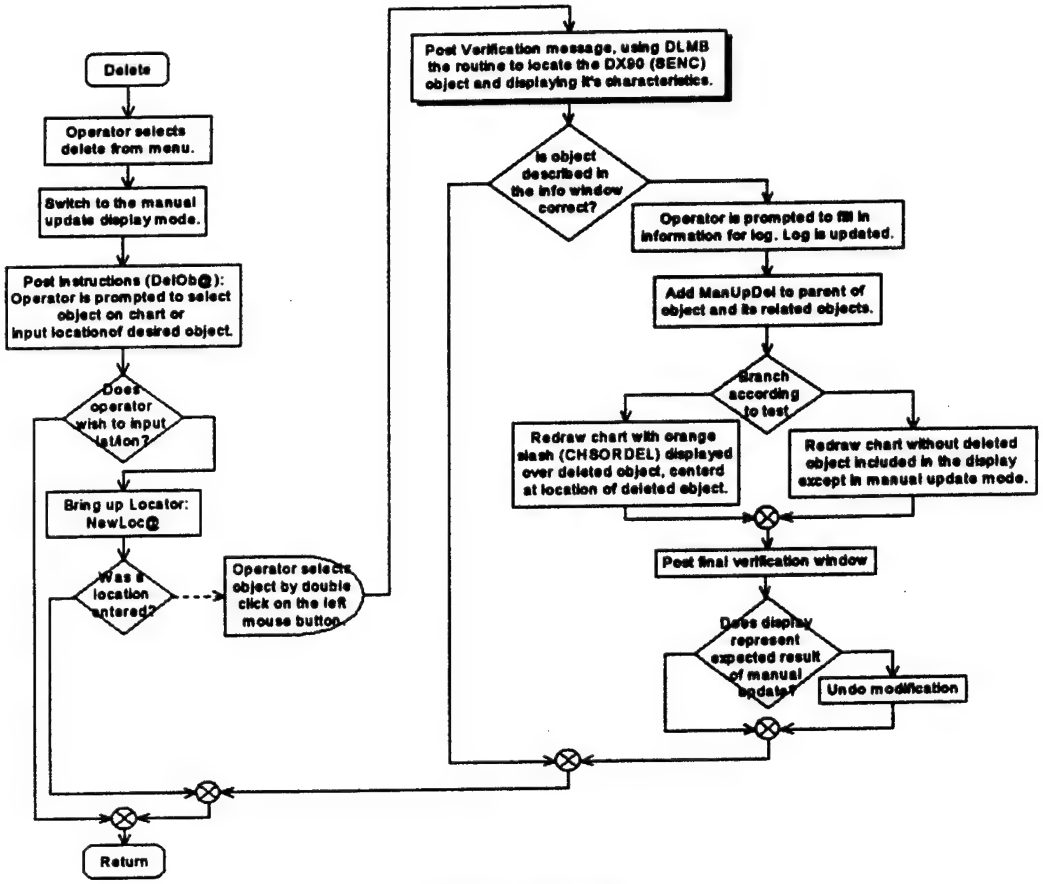
Location Editor
figure 2.7.2.3.2



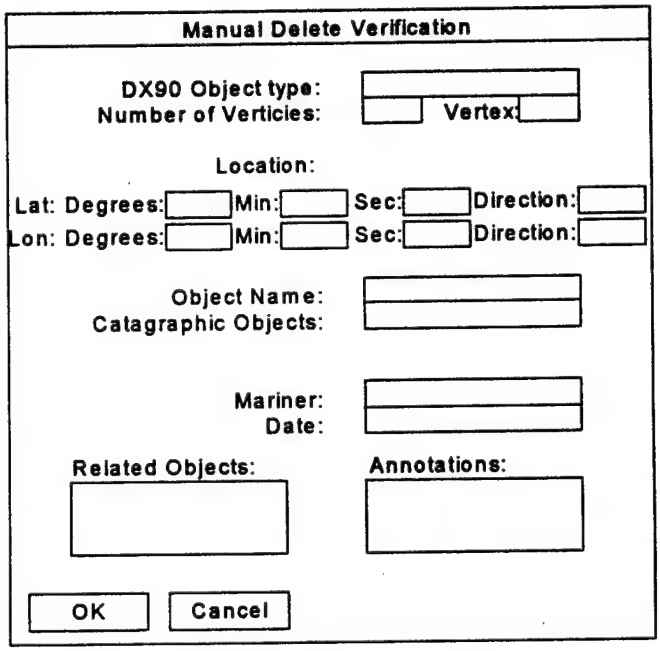
Additional Characteristics
figure 2.7.2.3.3.1



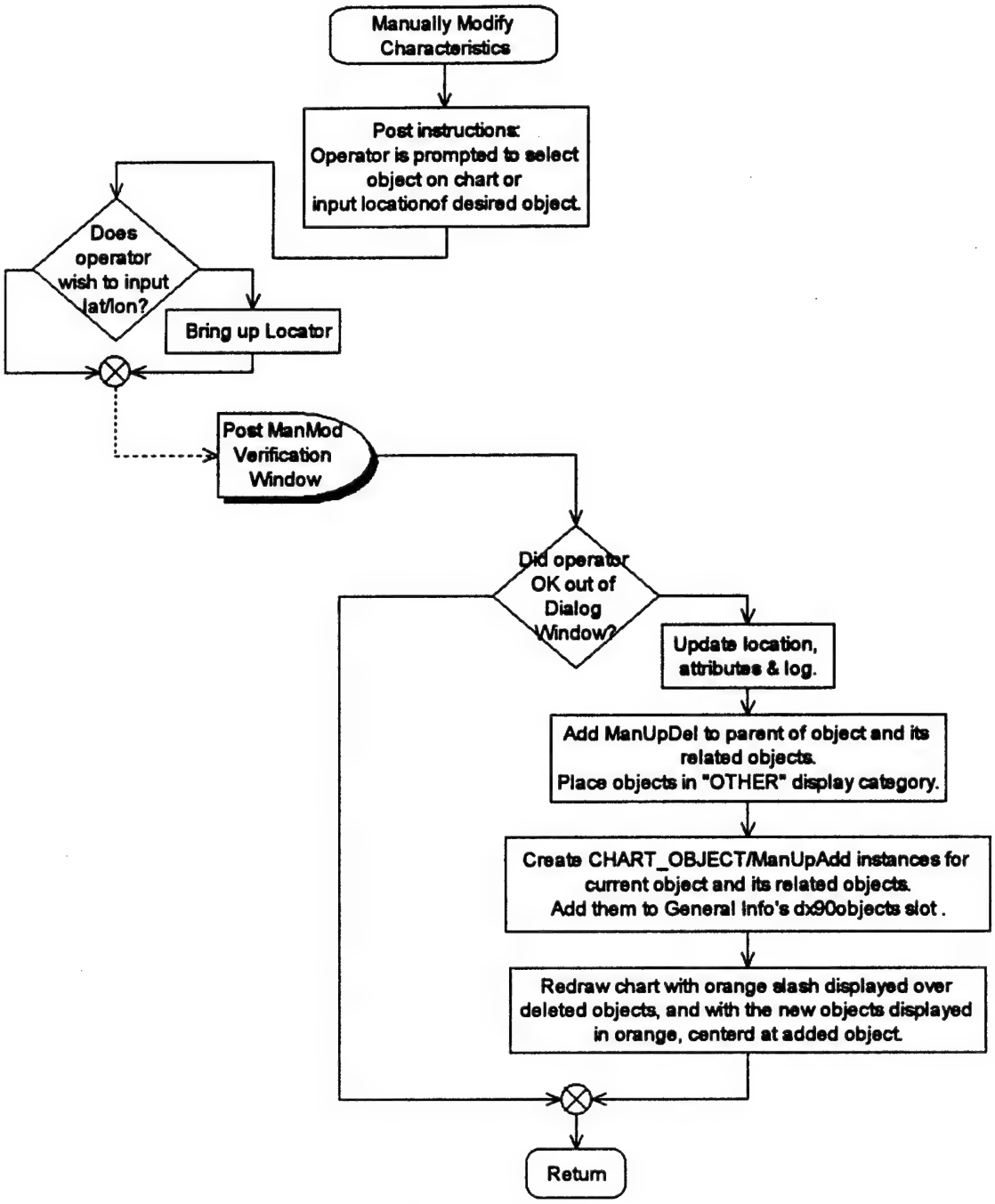
Add Attributes
figure 2.7.2.3.3.2



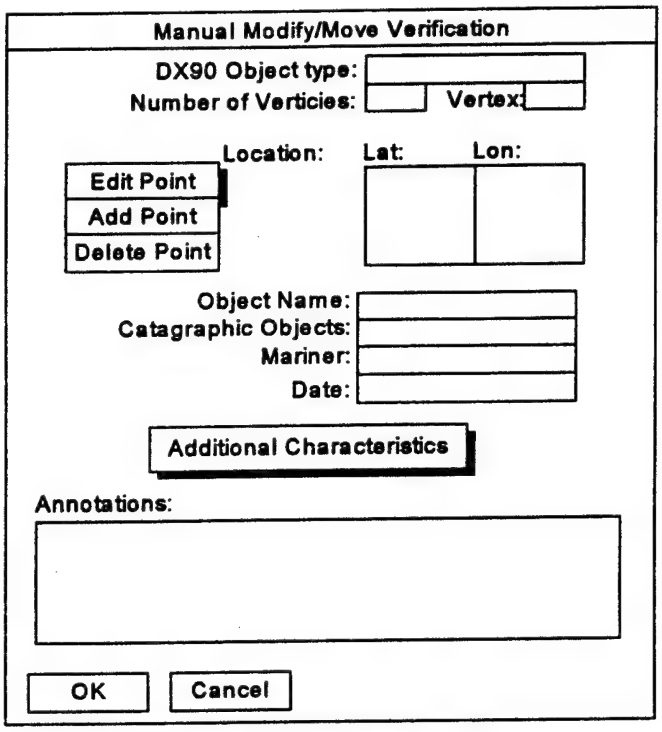
UpDel_React
figure 2.7.3.1



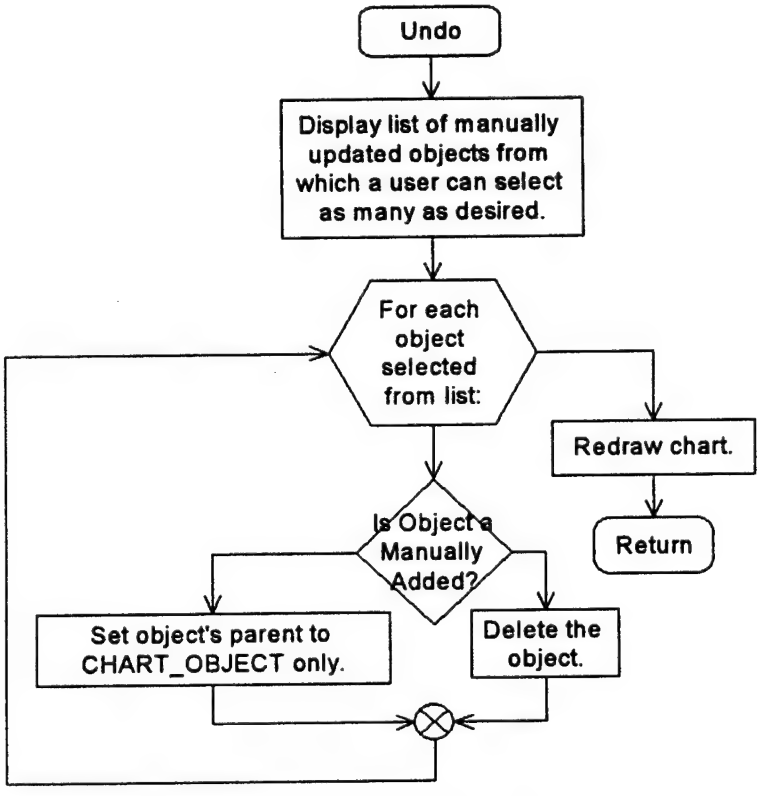
ManDel Verification
figure 2.7.3.2



UPMod_React
figure 2.7.4.1



ManMod Verification
figure 2.7.4.2



Undo Manual Update
figure 2.7.5.1

Utilities

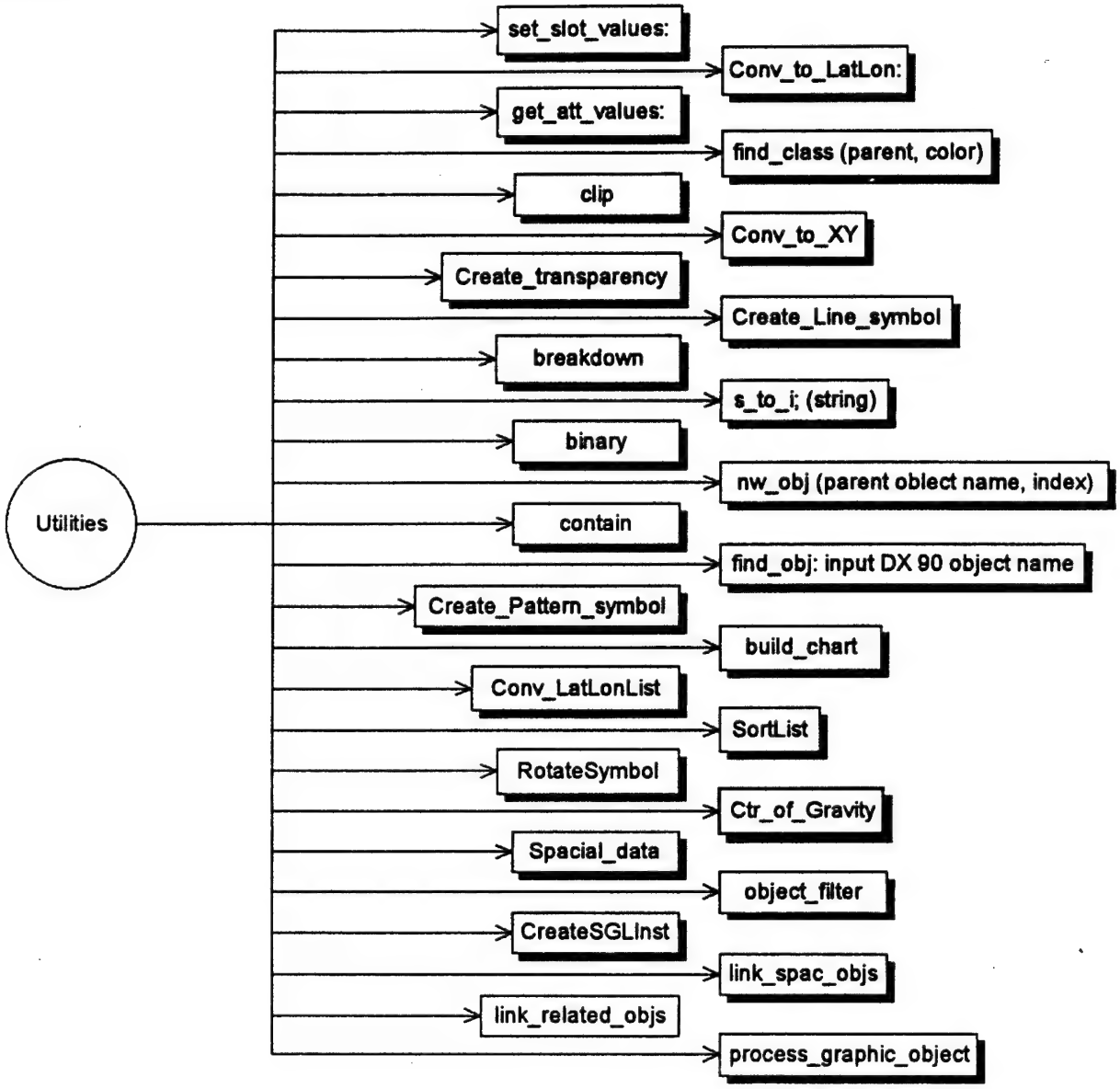
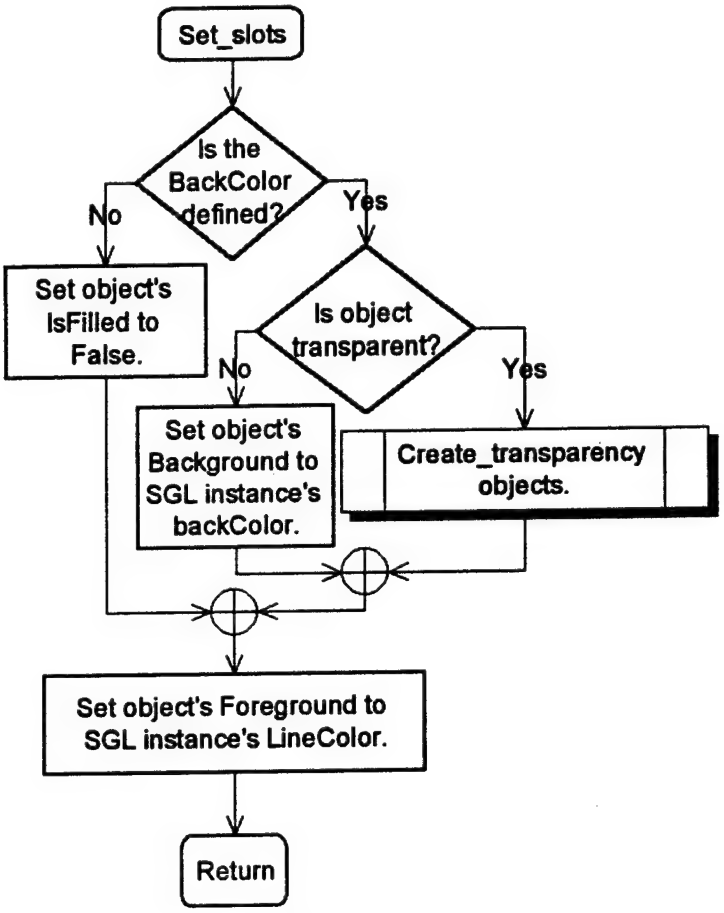
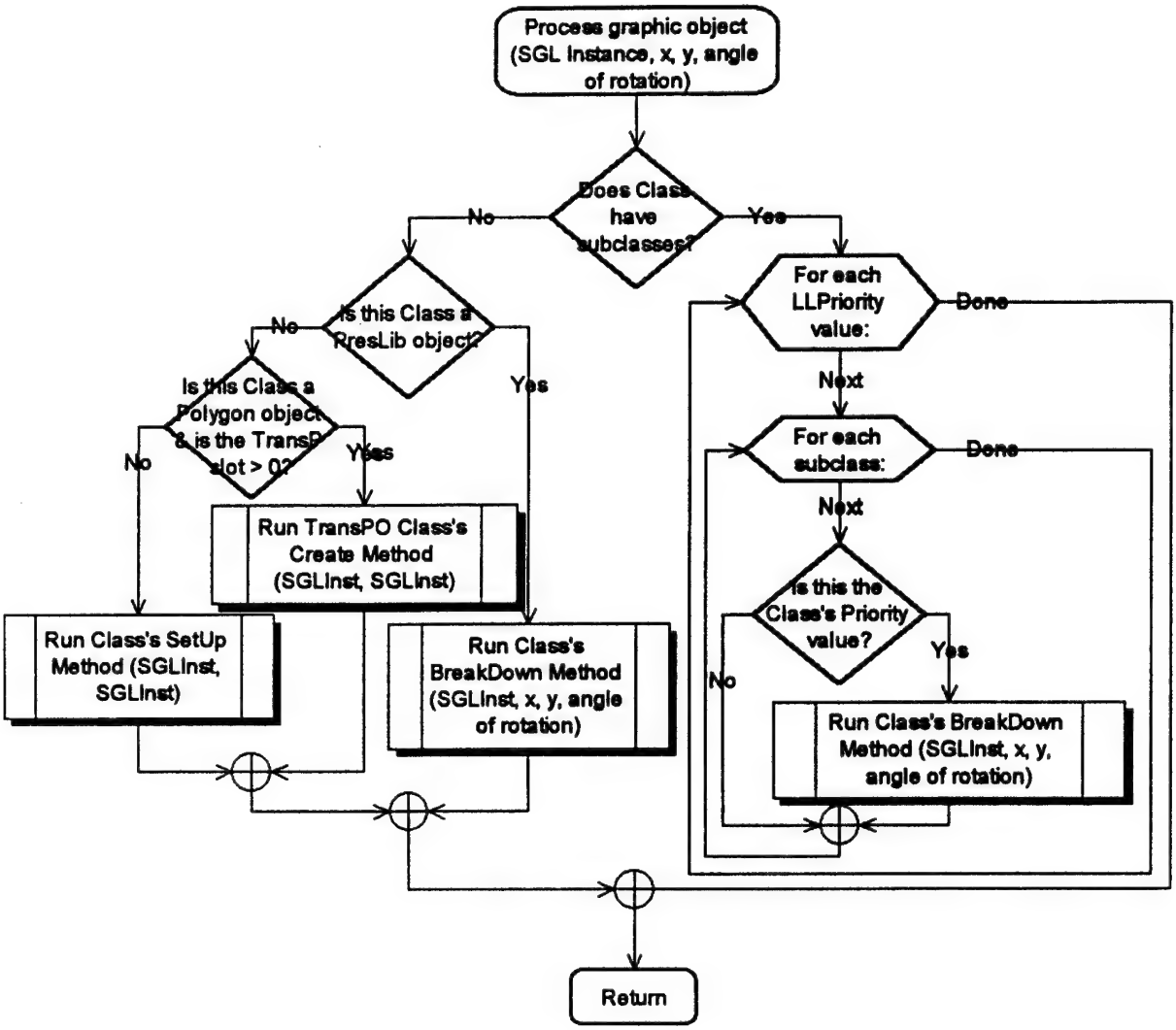


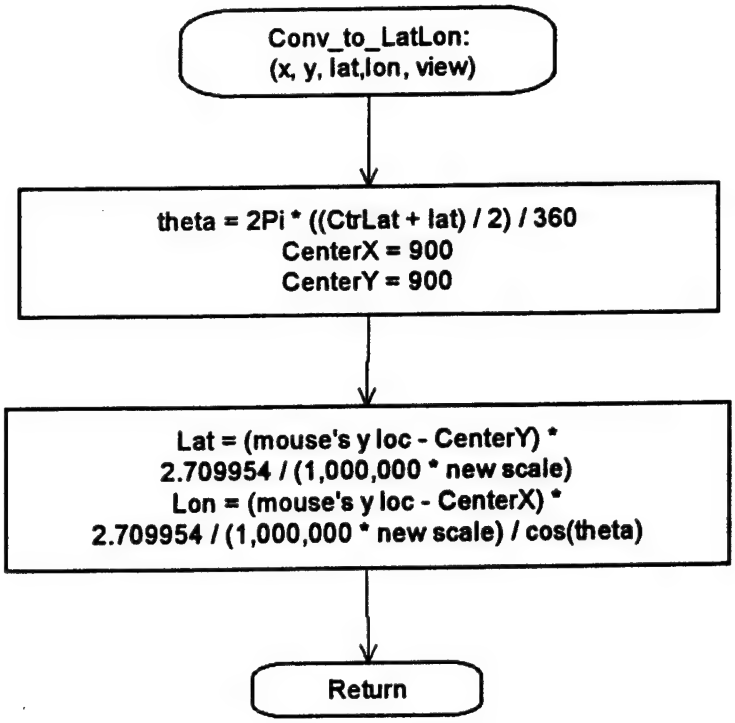
figure 2.8.1



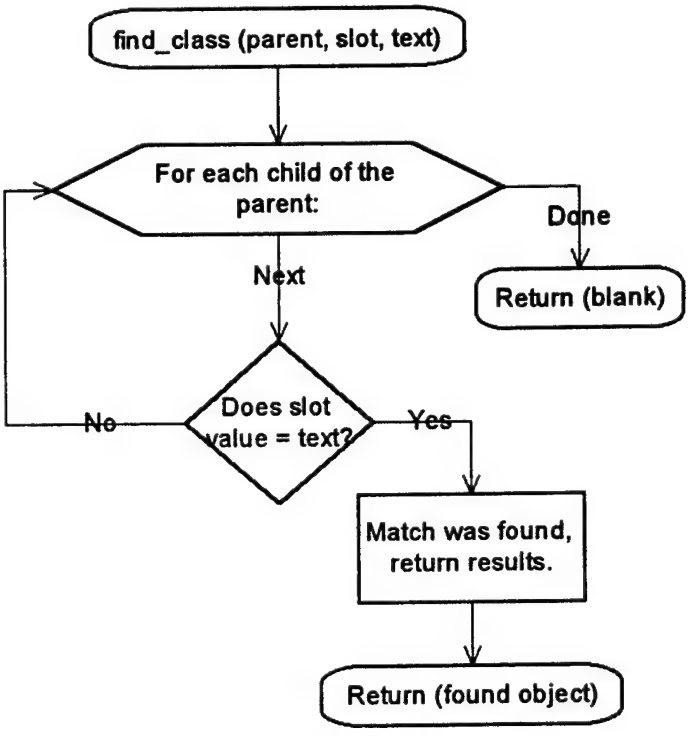
Set_slots
figure 2.8.2



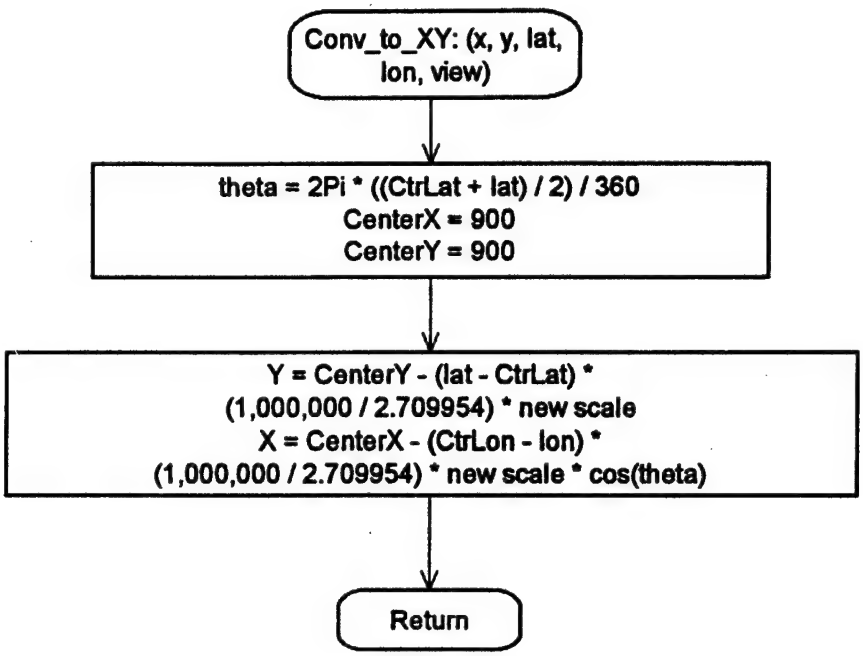
Process graphic object
figure 2.8.3



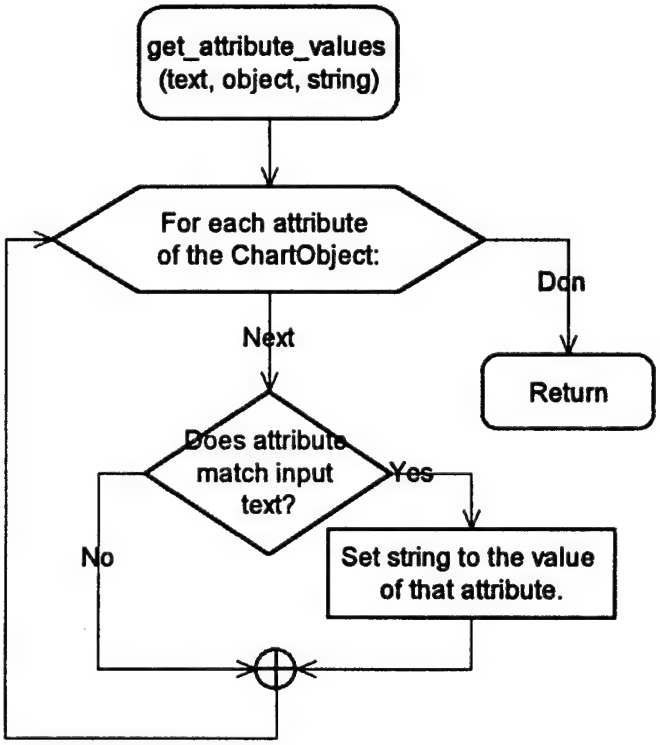
Conv_to_LatLon
figure 2.8.4



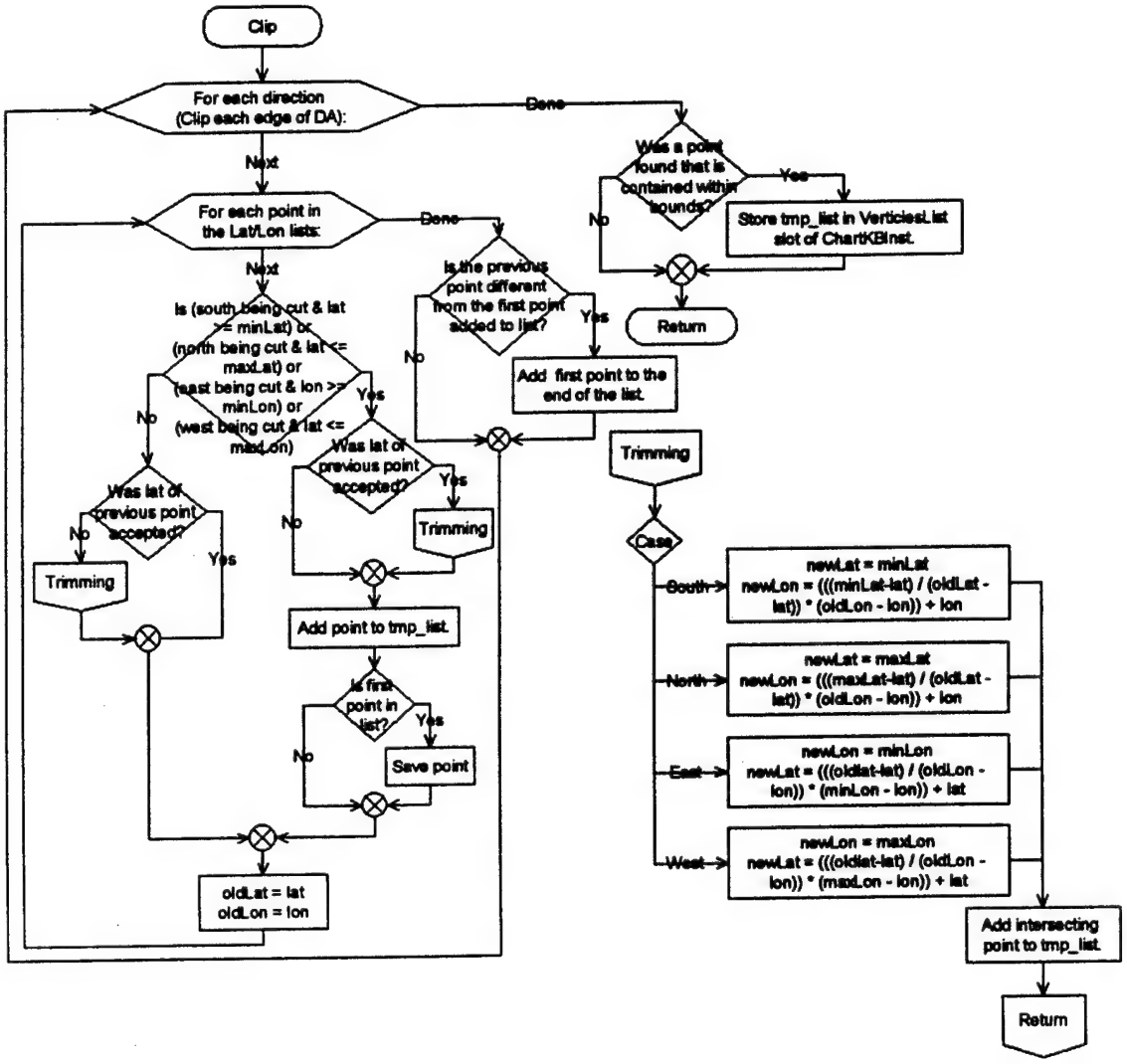
find_Class
figure 2.8.5



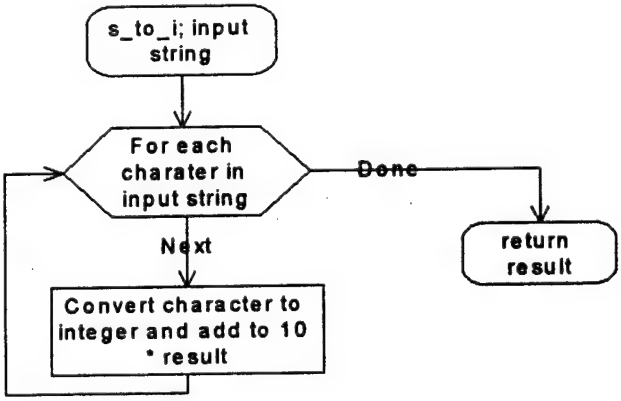
Conv_to_XY
figure 2.8.6



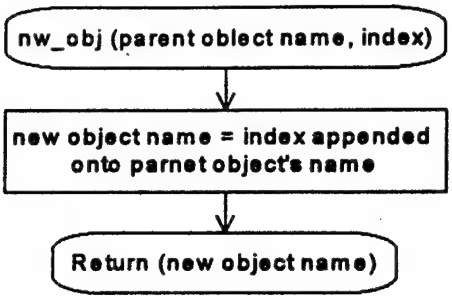
get_attribute_values
figure 2.8.7



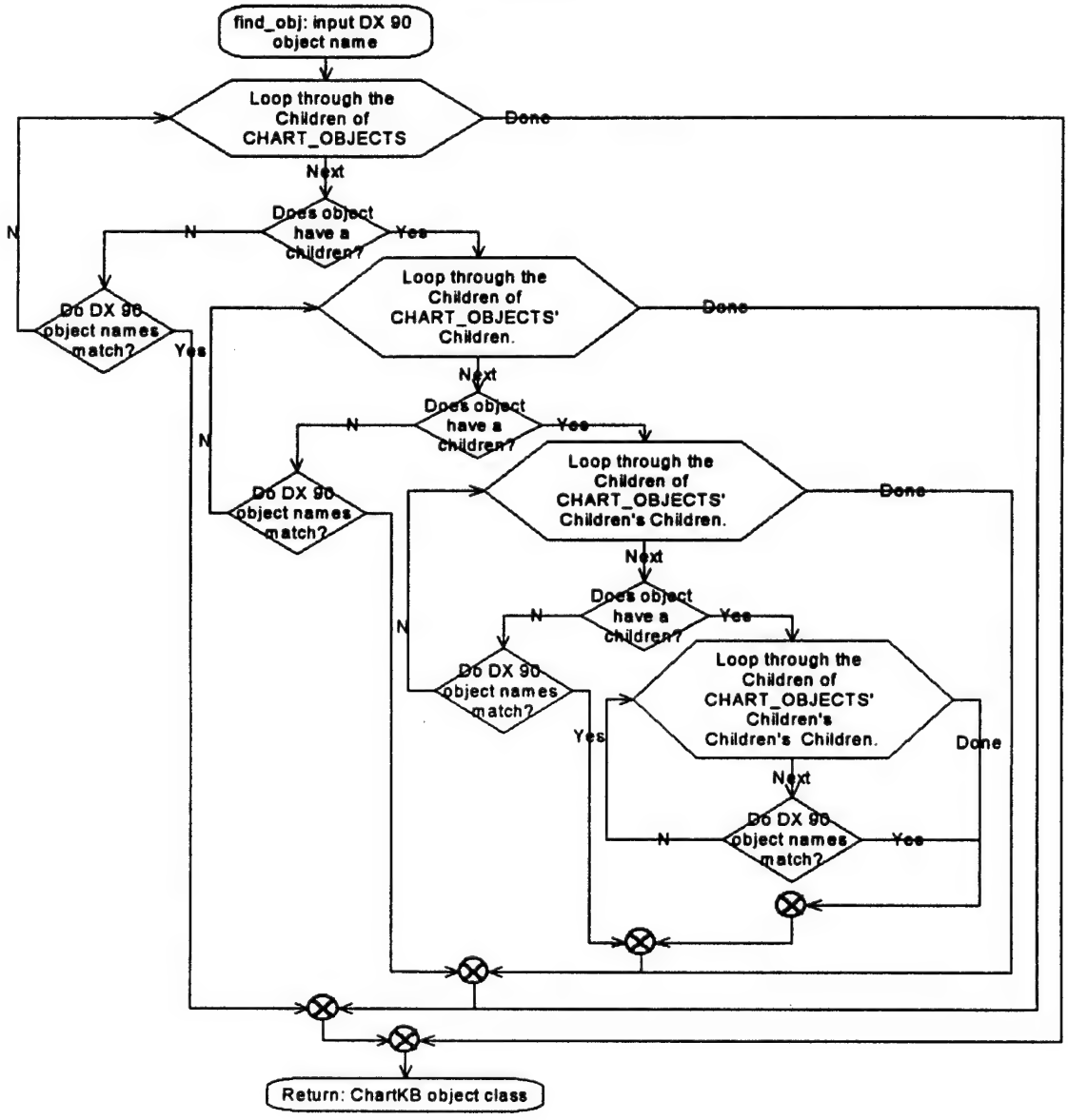
clip
figure 2.8.8



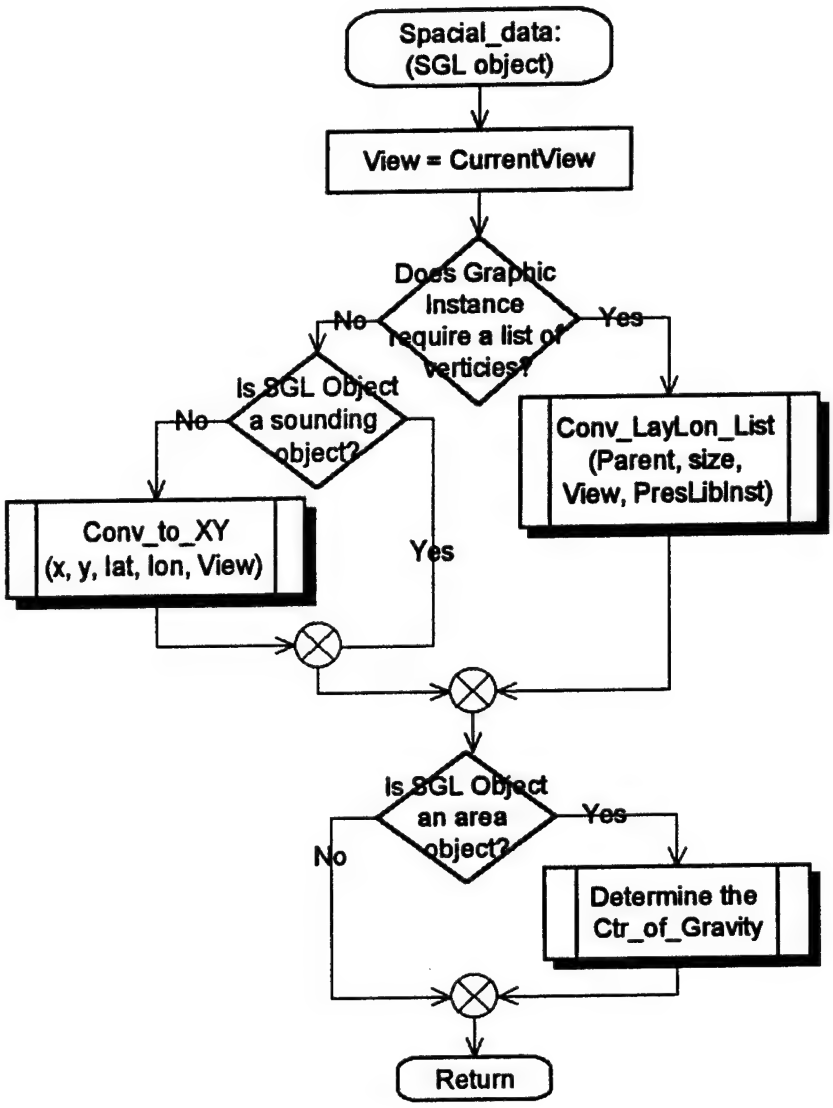
s_to_i
figure 2.8.9



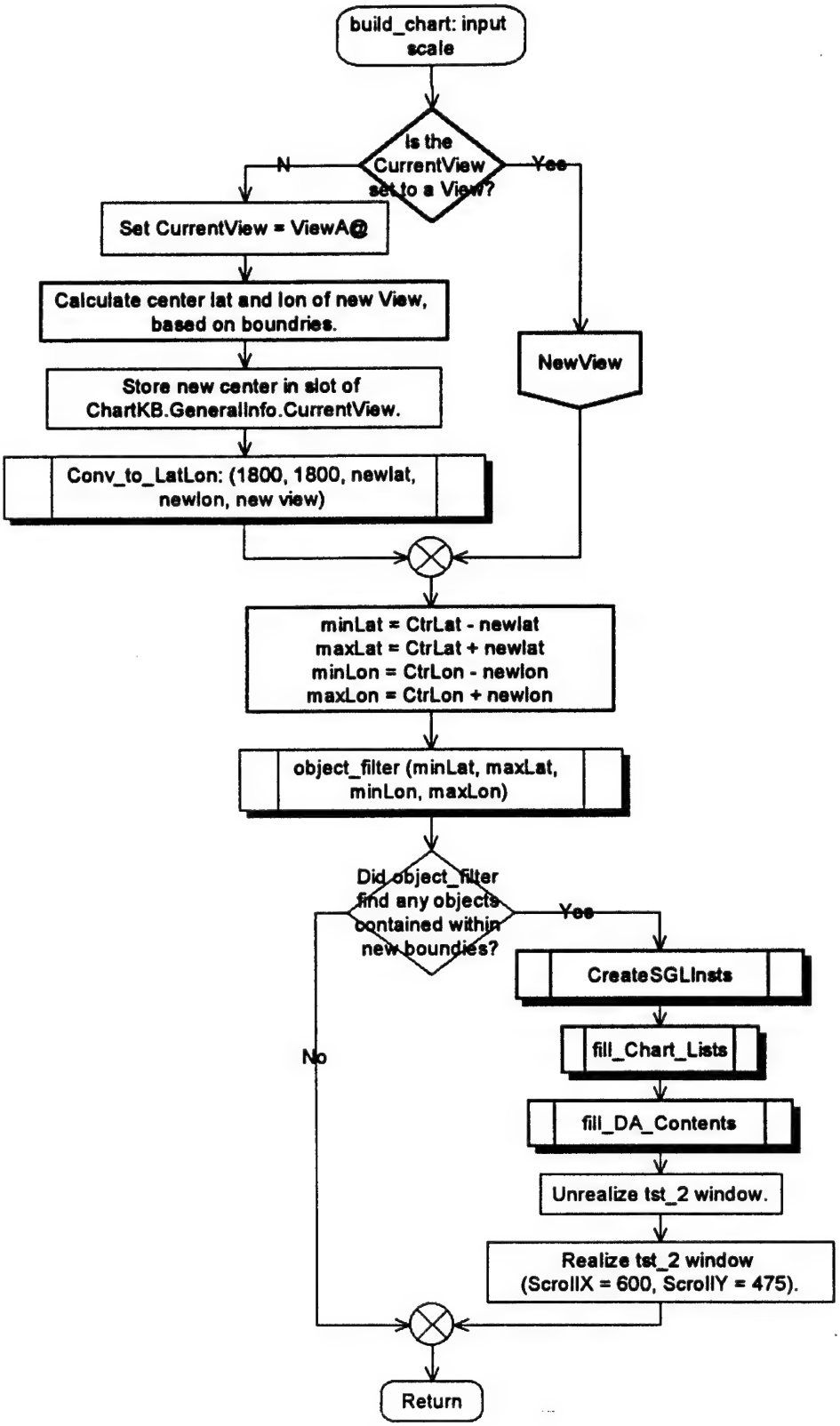
nw_obj
figure 2.8.10



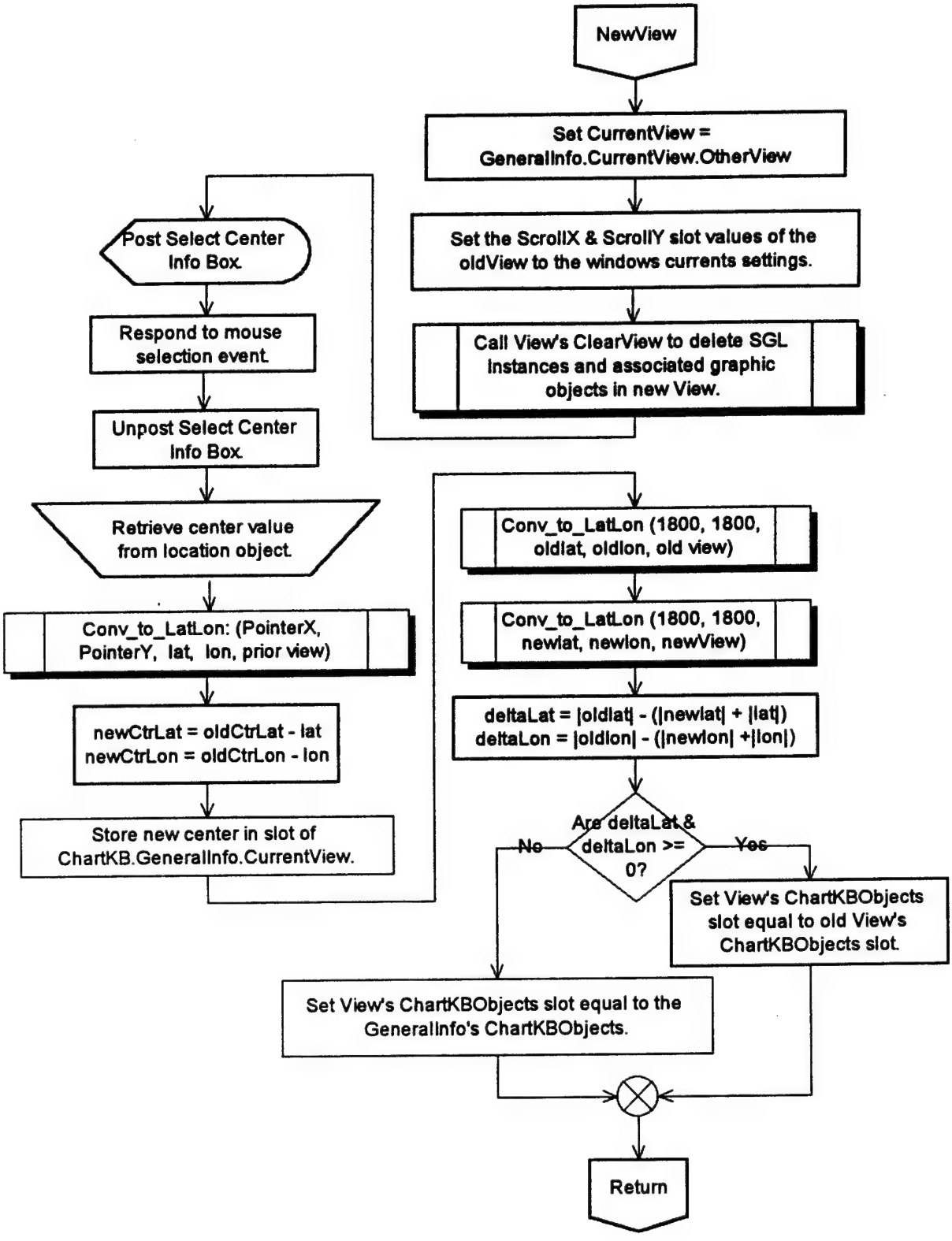
find_obj
figure 2.8.11



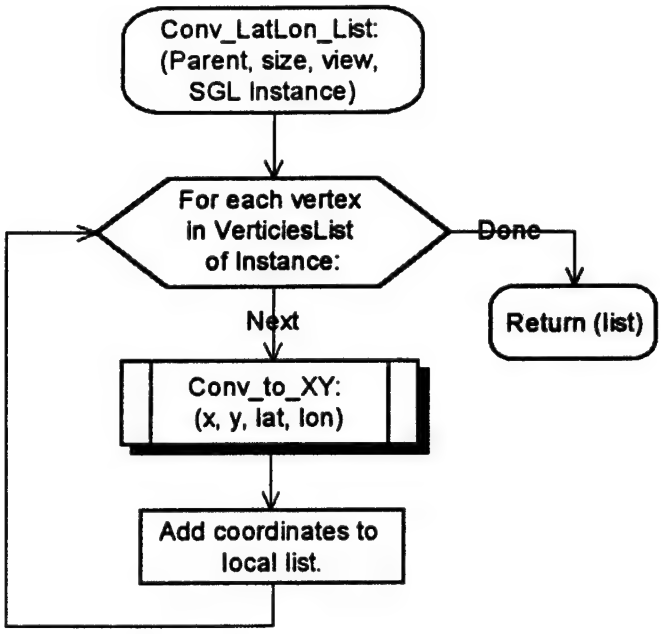
spacial_data
figure 2.8.12



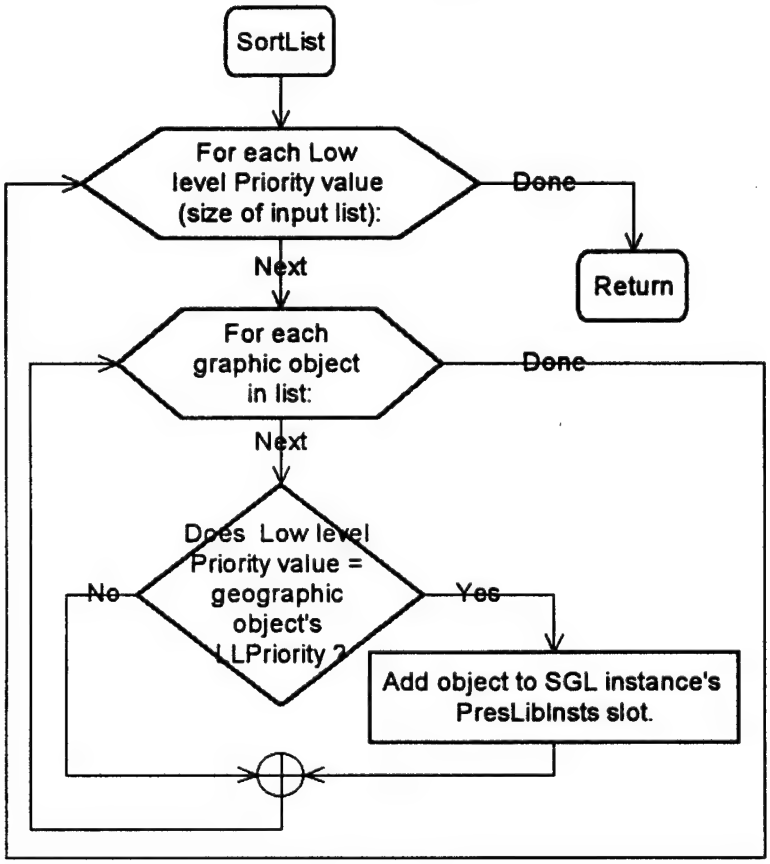
build_chart
figure 2.8.13.1



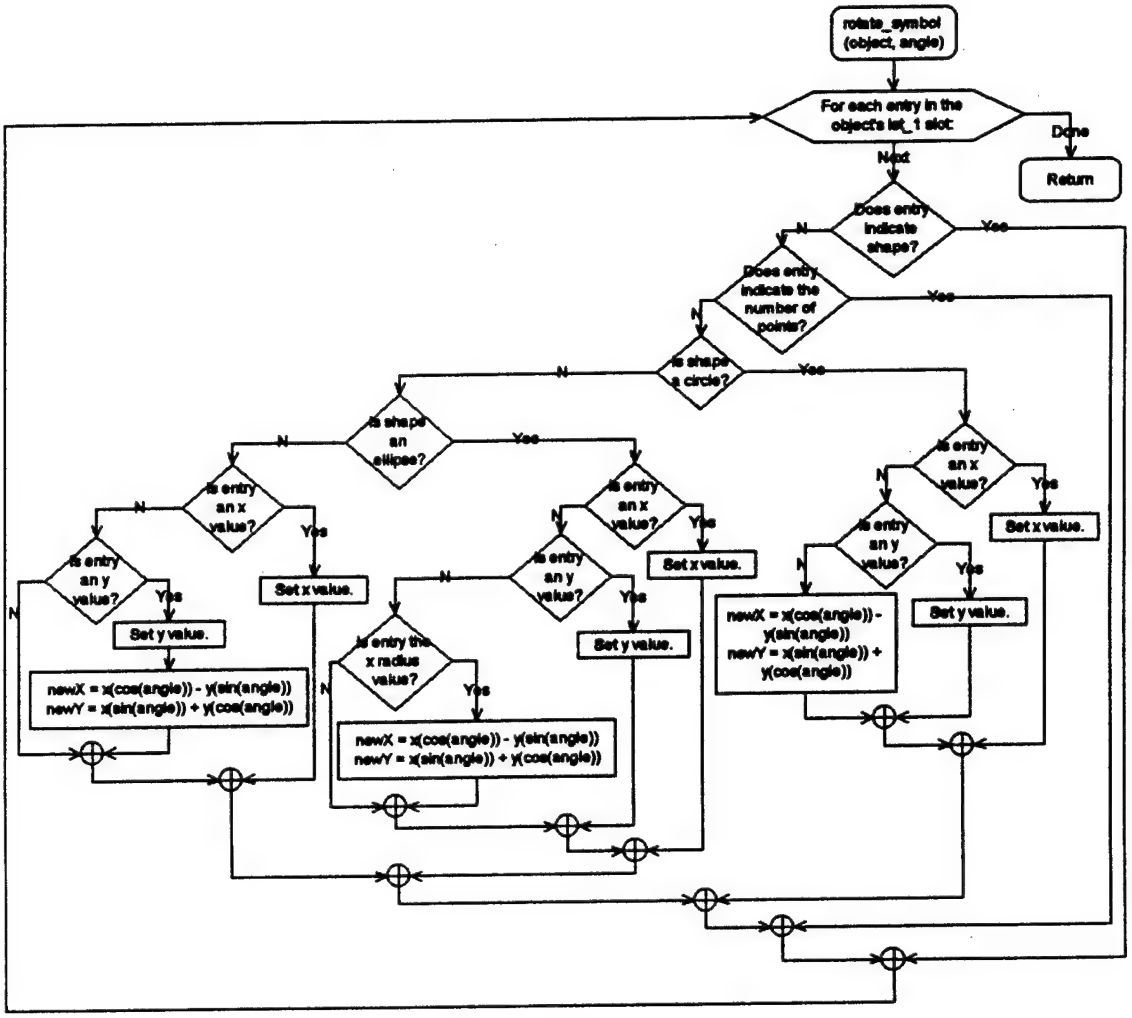
NewView
figure 2.8.13.2



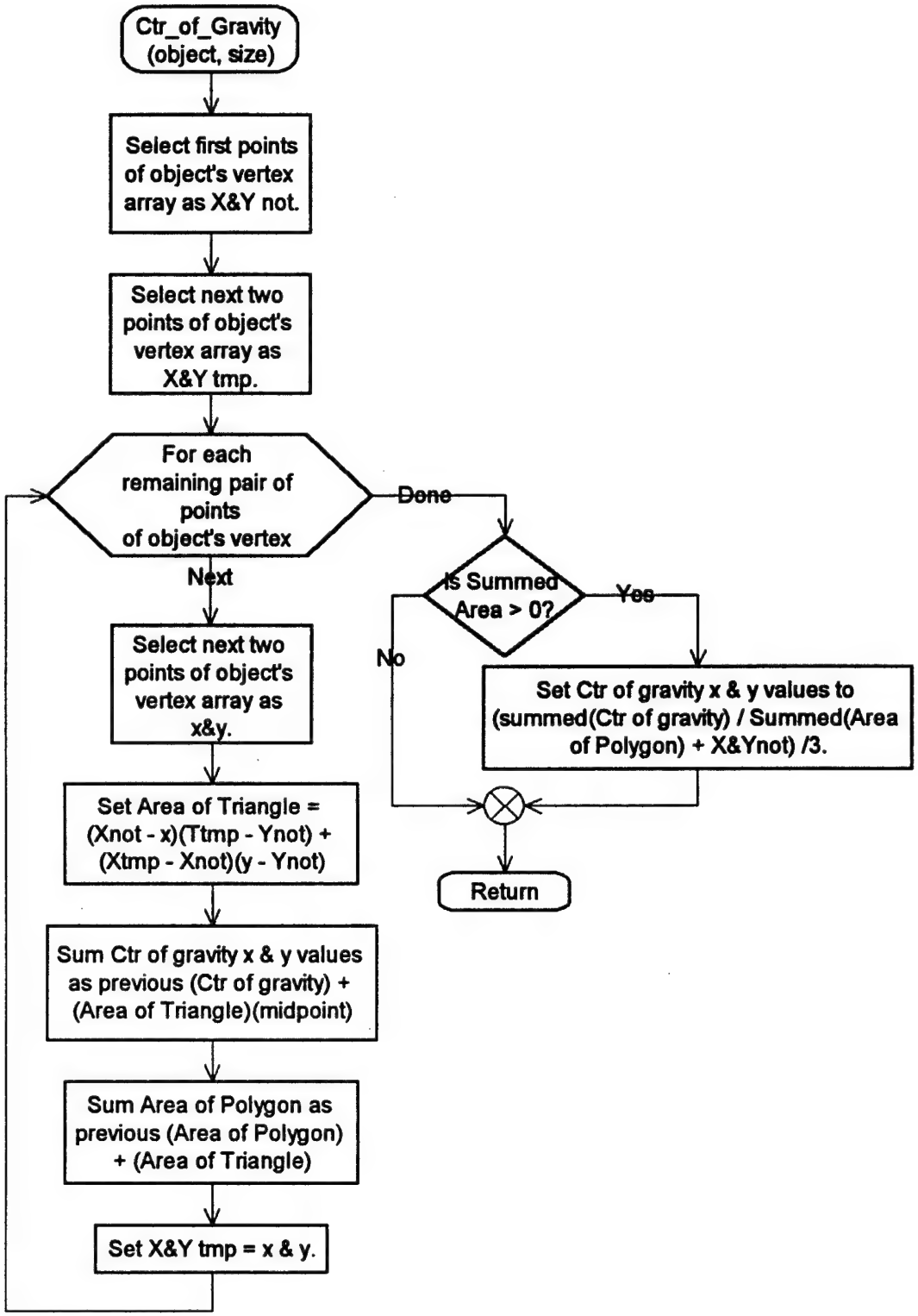
Conv_LatLonList
figure 2.8.14



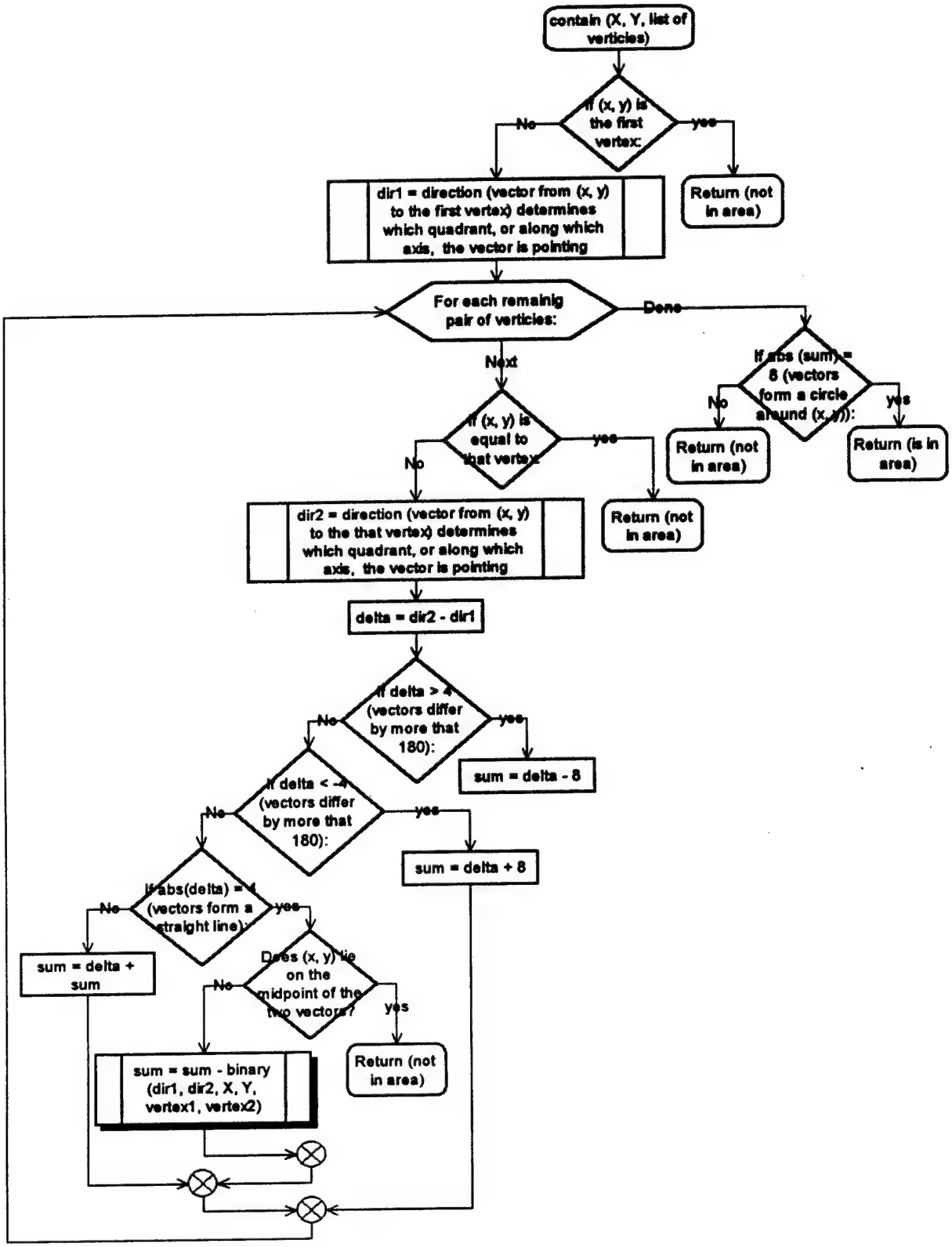
SortList
figure 2.8.15



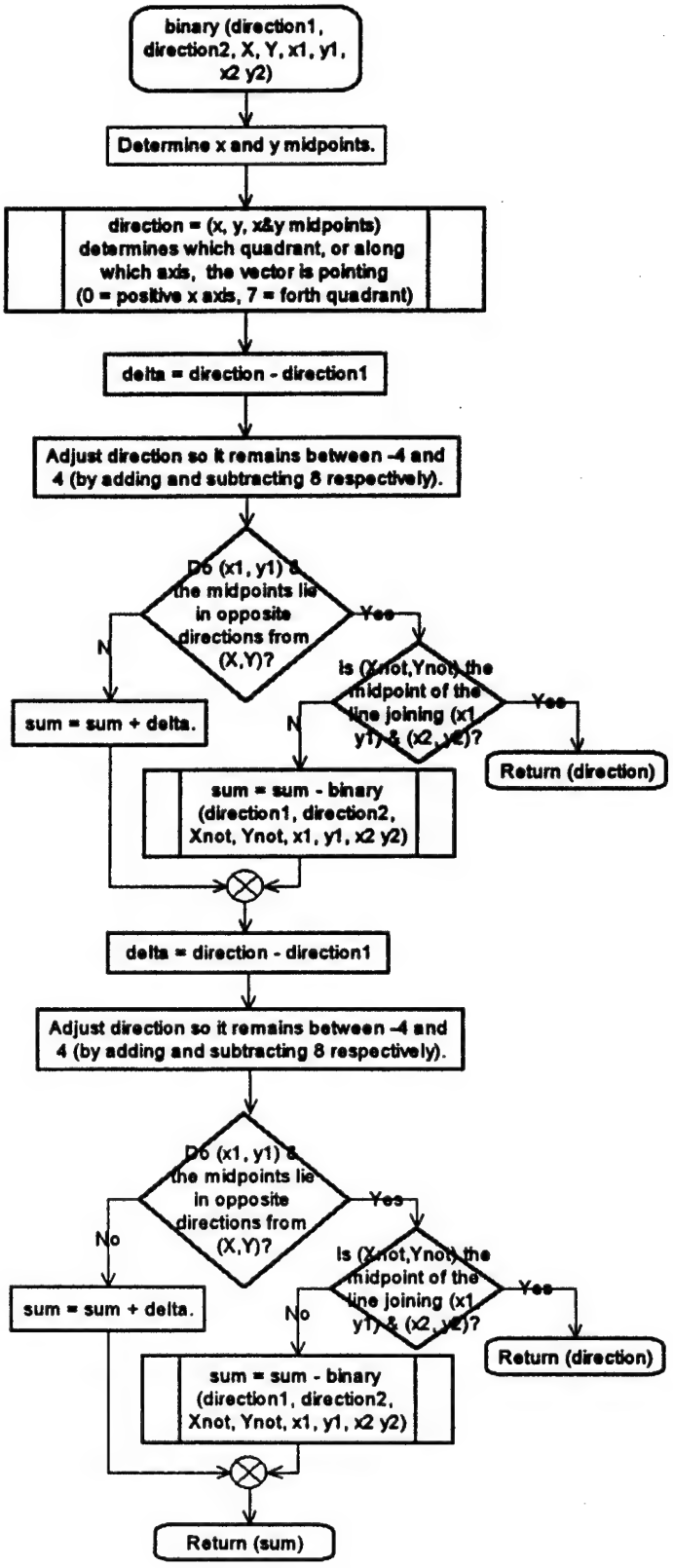
RotateSymbol
figure 2.8.16



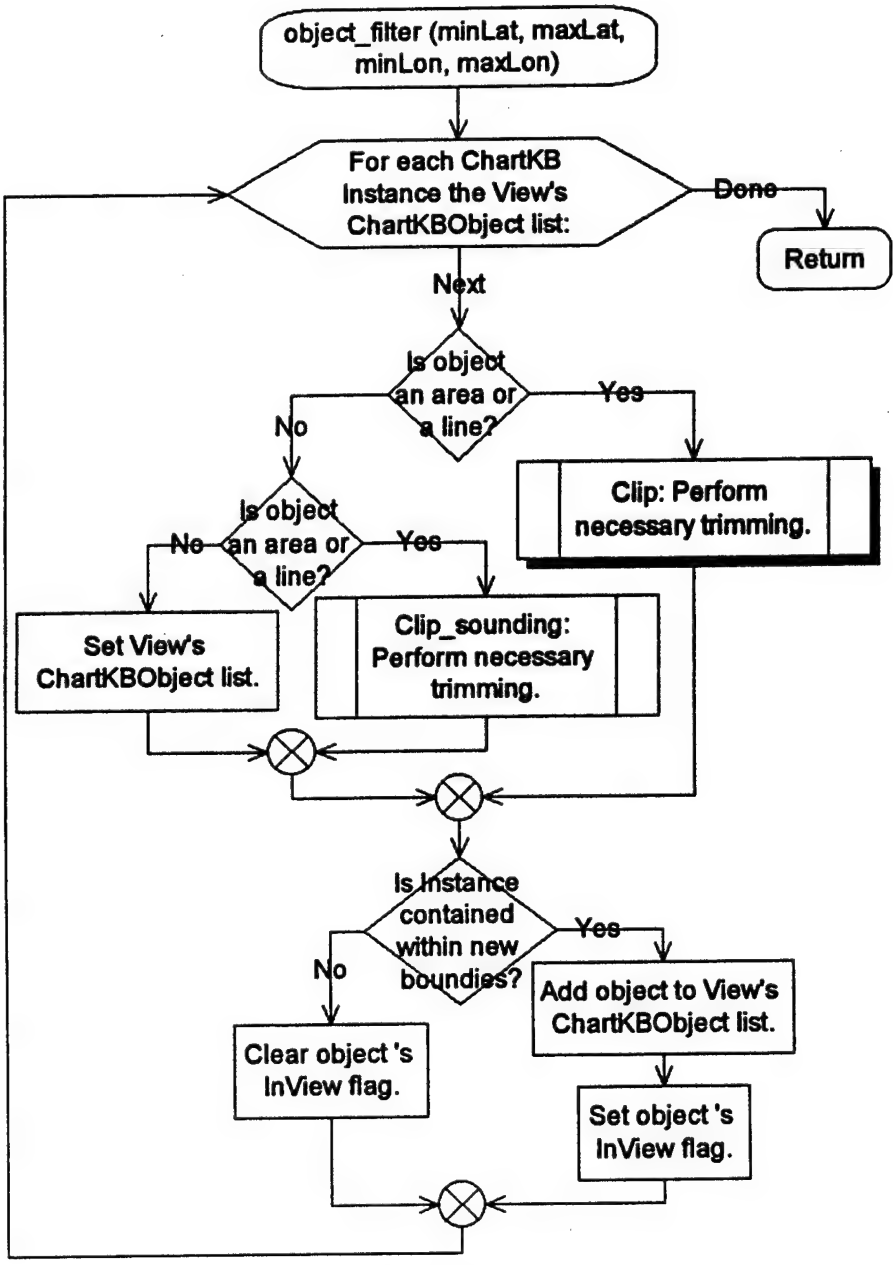
Ctr_of_Gravity
figure 2.8.17



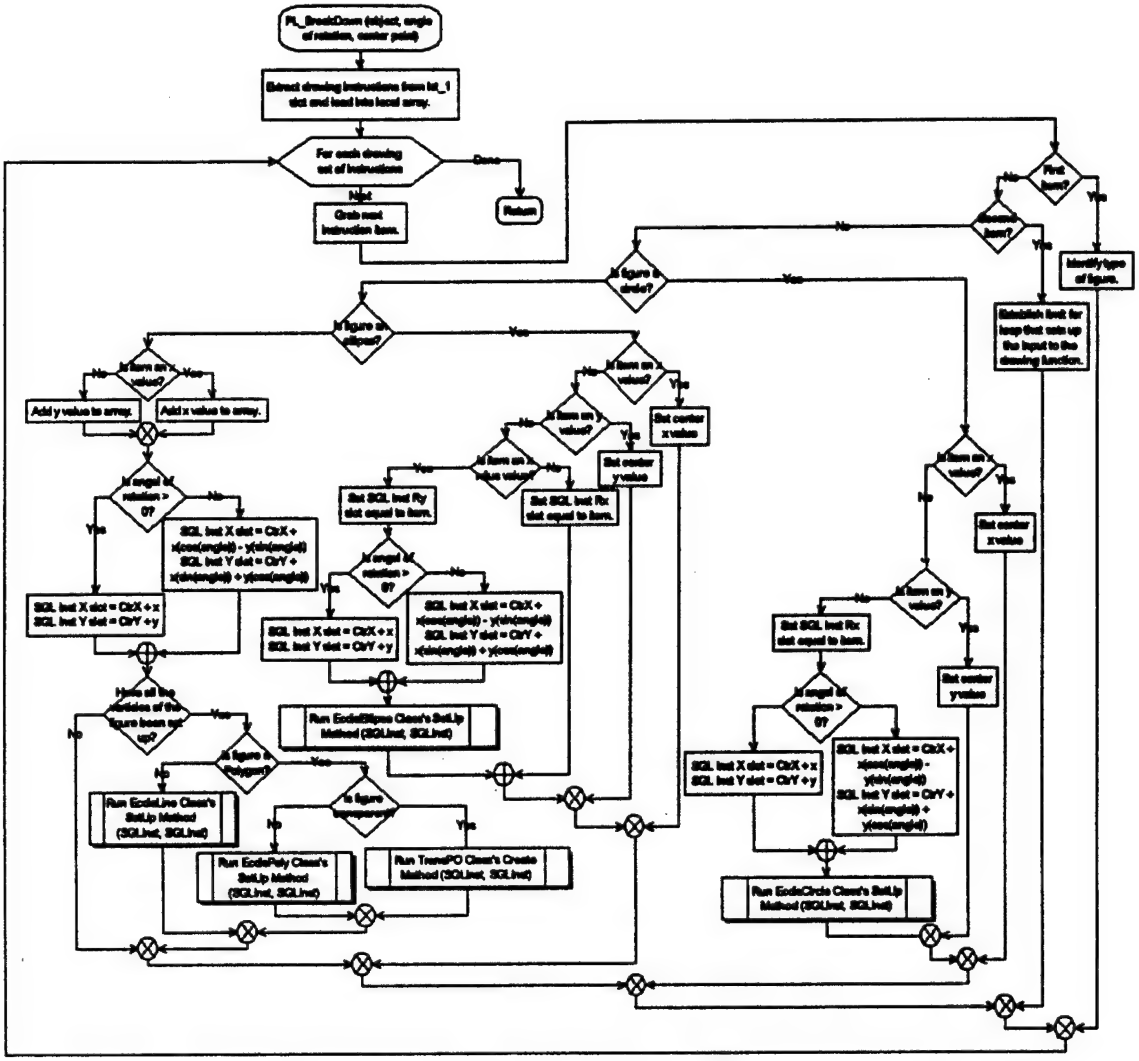
Contain
figure 2.8.18



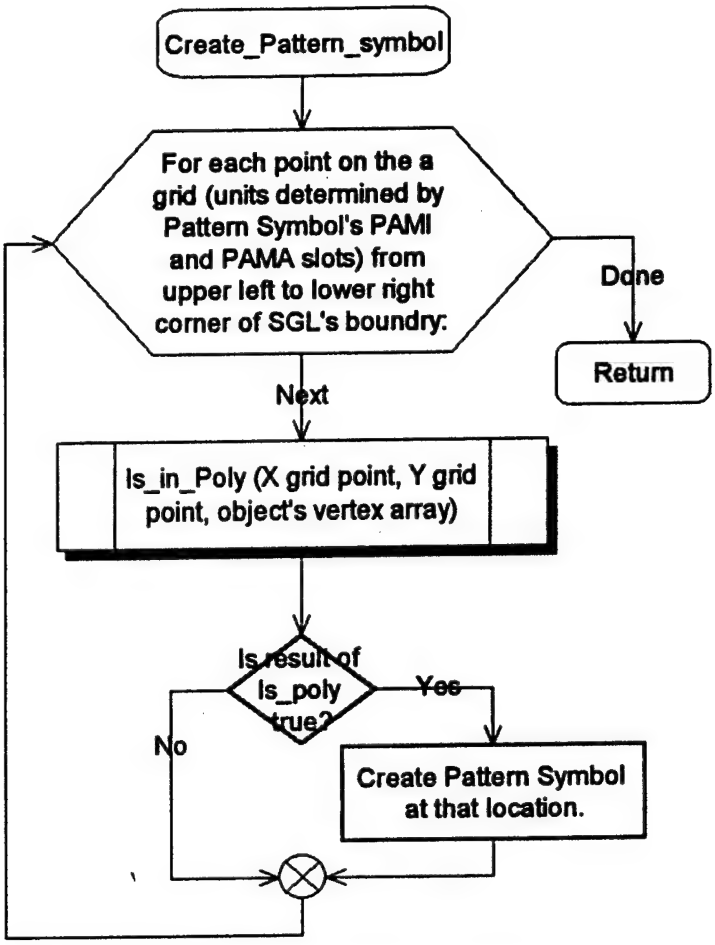
Binary
figure 2.8.19



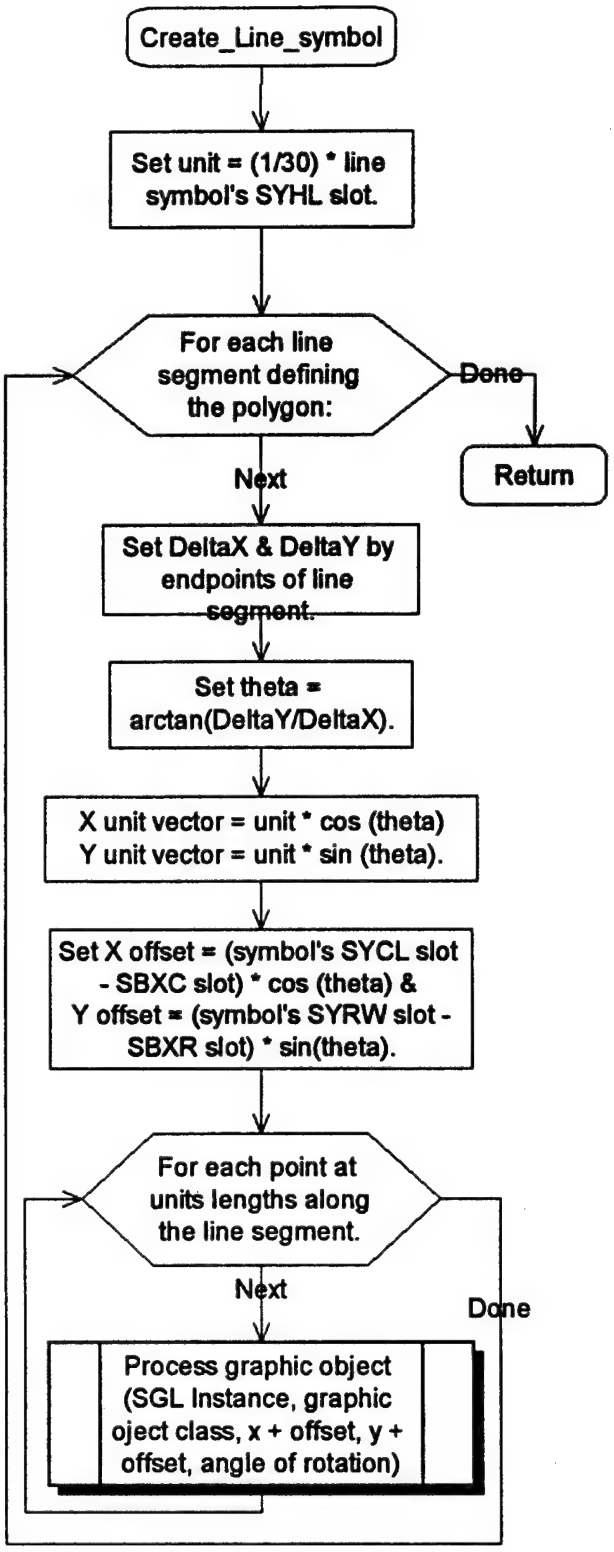
Object_filter
figure 2.8.20



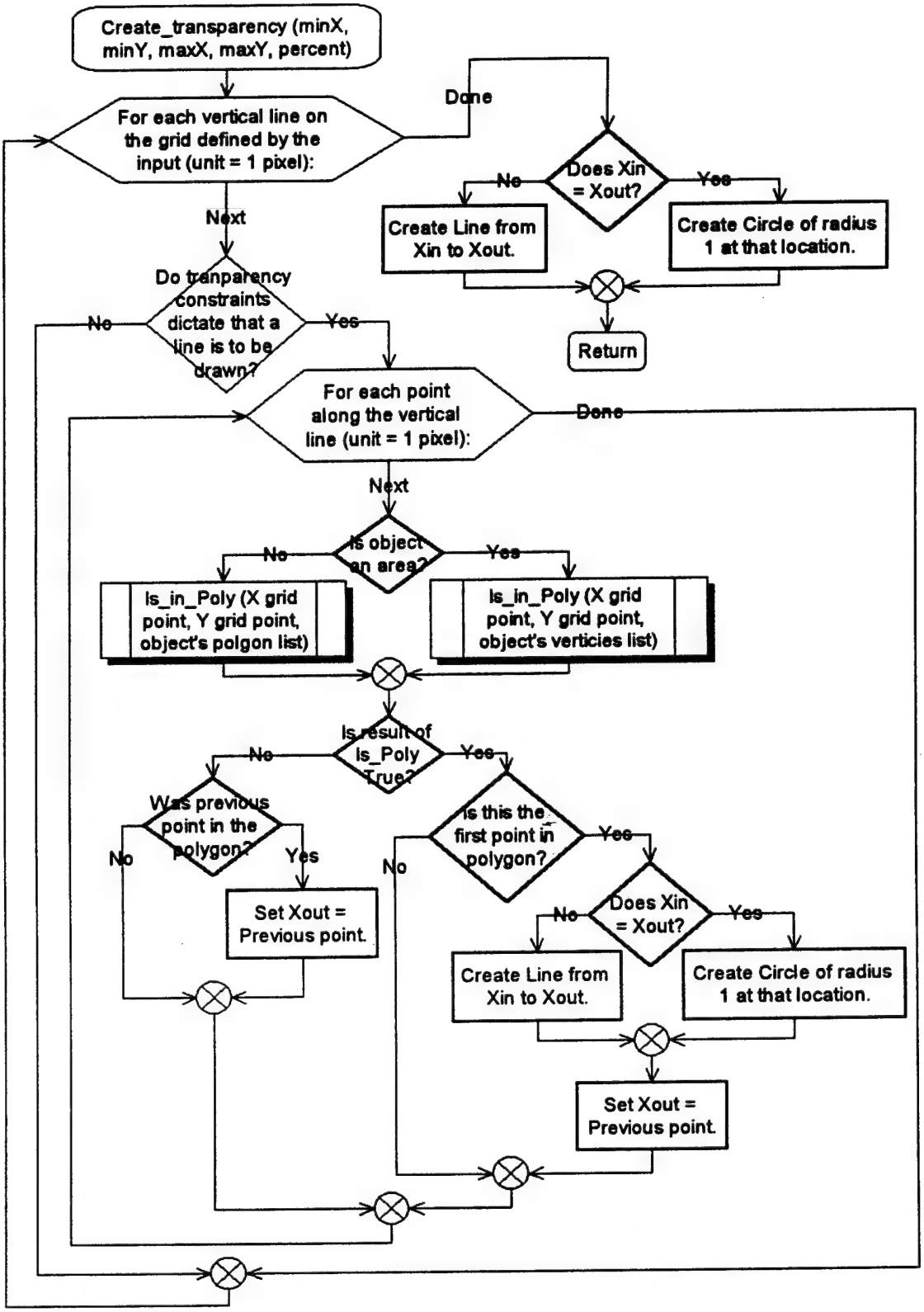
PL_Breakdown
figure 2.8.21



Create_Pattern_symbol
figure 2.8.22



Create_Line_symbol
figure 2.8.23



Create_transparency
figure 2.8.24

APPENDIX G - S57 VERSION 2 - OBJECTS AND ATTRIBUTES (November 1997)

Project Element 2720.2.2
Electronic Navigational Chart

Prepared by Unisys Corp.
Mark Nelson
for the: United States Coast Guard
Research and Development Center
1082 Shennecossett Road
Groton, CT 06340 - 6096

Objects_Attributes

Code	Object Class	Set	Attribute	Description
ACHARE	Anchorage area	A	STATUS	Status
			PERSTA	Periodic date. start
			PEREND	Periodic date. end
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			DATSTA	Date. start
			DATEND	Date. end
			CATACH	Category of anchorage
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
ACHBRT	Anchor berth	A	DATEND	Date. end
			DATSTA	Date. start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			PEREND	Periodic date. end
			PERSTA	Periodic date. start
			CATACH	Category of anchorage
			RADIUS	Radius
			STATUS	Status
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
ACHPNT	Anchor	A	PEREND	Periodic date. end
			DATSTA	Date. start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			PERSTA	Periodic date. start
			QUASOU	Quality of sounding measurement
			TECSOU	Technique of sounding measurement
			VALSOU	Value of sounding
			VERDAT	Vertical datum
			DATEND	Date. end
			STATUS	Status
		B	SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
AIRARE	Airport area	A	CONDTN	Condition
			NATCON	Nature of construction
			CATAIR	Category of airport
			CONVIS	Conspicuous. visual
			STATUS	Status
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
BCNCAR	Beacon. cardinal	A	NOBJNM	Object name in National Character Set
			VERLEN	Vertical length

Code	Object Class	Set	Attribute	Description
BCNCAR	Beacon. cardinal	A	STATUS	Status
			QUAVEM	Quality of vertical measurement
			PERSTA	Periodic date. start
			PEREND	Periodic date. end
			OBJNAM	Object name
			VERDAT	Vertical datum
			CONRAD	Conspicuous. radar
			DATSTA	Date. start
			DATEND	Date. end
			COLPAT	Colour pattern
			COLMAR	Colour of navigational mark
			BCNSHP	Beacon shape
			CATCAM	Category of cardinal mark
			MARSYS	Marks navigational - System of
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
BCNISD	Beacon. isolated danger	A	MARSYS	Marks navigational - System of
			VERDAT	Vertical datum
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			PERSTA	Periodic date. start
			PEREND	Periodic date. end
			VERLEN	Vertical length
			DATSTA	Date. start
			DATEND	Date. end
			CONRAD	Conspicuous. radar
			COLPAT	Colour pattern
			COLMAR	Colour of navigational mark
			BCNSHP	Beacon shape
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
BCNLAT	Beacon. lateral	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			VERLEN	Vertical length
			VERDAT	Vertical datum
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			PEREND	Periodic date. end
			DATSTA	Date. start
			BCNSHP	Beacon shape
			DATEND	Date. end
			MARSYS	Marks navigational - System of
			CONRAD	Conspicuous. radar
			COLPAT	Colour pattern
			COLMAR	Colour of navigational mark
			CATLAM	Category of lateral mark
			PERSTA	Periodic date. start
		B	PICREP	Pictorial representation
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
BCNSAW	Beacon. safe water	A	VERDAT	Vertical datum
			OBJNAM	Object name
			VERLEN	Vertical length

Code	Object Class	Set	Attribute	Description
BCNSAW	Beacon, safe water	A	STATUS	Status
			QUAVEM	Quality of vertical measurement
			PERSTA	Periodic date, start
			PEREND	Periodic date, end
			MARSYS	Marks navigational - System of
			DATSTA	Date, start
			DATEND	Date, end
			CONRAD	Conspicuous, radar
			COLPAT	Colour pattern
			COLMAR	Colour of navigational mark
			BCNSHP	Beacon shape
			NOBJNM	Object name in National Character Set
		B	SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
BCNSPP	Beacon, special purpose	A	COLMAR	Colour of navigational mark
			OBJNAM	Object name
			VERDAT	Vertical datum
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			VERLEN	Vertical length
			PERSTA	Periodic date, start
			PEREND	Periodic date, end
			NOBJNM	Object name in National Character Set
			MARSYS	Marks navigational - System of
			DATSTA	Date, start
			DATEND	Date, end
			COLPAT	Colour pattern
			CATSPM	Category of special purpose mark
			BCNSHP	Beacon shape
			CONRAD	Conspicuous, radar
		B	INFORM	Information
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
BOYCAR	Buoy, cardinal	A	MARSYS	Marks navigational - System of
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			PERSTA	Periodic date, start
			PEREND	Periodic date, end
			NOBJNM	Object name in National Character Set
			VERLEN	Vertical length
			DATSTA	Date, start
			DATEND	Date, end
			CONRAD	Conspicuous, radar
			COLPAT	Colour pattern
			COLMAR	Colour of navigational mark
			CATCAM	Category of cardinal mark
			BOYSHP	Buoy shape
			OBJNAM	Object name
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			PICREP	Pictorial representation
			INFORM	Information
			NINFOM	Information in National Character Set
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
BOYINB	Buoy, installation	A	BOYSHP	Buoy shape
			CATINB	Category of installation buoy
			COLMAR	Colour of navigational mark
			COLPAT	Colour pattern
			CONRAD	Conspicuous, radar

Code	Object Class	Set	Attribute	Description
BOYINB	Buov. installation	A	DATEND	Date. end
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			PEREND	Periodic date. end
			PERSTA	Periodic date. start
			QUAVEM	Quality of vertical measurement
			STATUS	Status
			VERLEN	Vertical length
			DATSTA	Date. start
			MARSYS	Marks navigational - System of
		B	INFORM	Information
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
BOYISD	Buov. isolated danger	A	OBJNAM	Object name
			DATSTA	Date. start
			VERLEN	Vertical length
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			PRODCT	Product
			BOYSHP	Buoy shape
			PEREND	Periodic date. end
			MARSYS	Marks navigational - System of
			DATEND	Date. end
			CONRAD	Conspicuous. radar
			COLPAT	Colour pattern
			COLMAR	Colour of navigational mark
			PERSTA	Periodic date. start
			NOBJNM	Object name in National Character Set
		B	NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
BOYLAT	Buov. lateral	A	CATLAM	Category of lateral mark
			MARSYS	Marks navigational - System of
			QUAVEM	Quality of vertical measurement
			PERSTA	Periodic date. start
			PEREND	Periodic date. end
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			DATSTA	Date. start
			DATEND	Date. end
			CONRAD	Conspicuous. radar
			COLMAR	Colour of navigational mark
			VERLEN	Vertical length
			BOYSHP	Buoy shape
			COLPAT	Colour pattern
			STATUS	Status
		B	INFORM	Information
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
BOYSAW	Buov. safe water	A	BOYSHP	Buoy shape
			PEREND	Periodic date. end
			STATUS	Status
			VERLEN	Vertical length
			QUAVEM	Quality of vertical measurement
			PERSTA	Periodic date. start
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set

Code	Object Class	Set	Attribute	Description
BOYSAW	Buoy, safe water	A	MARSYS	Marks navigational - System of
			DATEND	Date, end
			COLMAR	Colour of navigational mark
			CONRAD	Conspicuous, radar
			COLPAT	Colour pattern
			DATSTA	Date, start
		B	NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
BOYSPP	Buoy, special purpose	A	CONRAD	Conspicuous, radar
			BOYSHP	Buoy shape
			COLMAR	Colour of navigational mark
			COLPAT	Colour pattern
			DATSTA	Date, start
			MARSYS	Marks navigational - System of
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			PEREND	Periodic date, end
			PERSTA	Periodic date, start
			QUAVEM	Quality of vertical measurement
			STATUS	Status
			VERLEN	Vertical length
			CATSPM	Category of special purpose mark
			DATEND	Date, end
		B	INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
		C	RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
BRIDGE	Bridge	A	VERCCL	Vertical clearance, closed
			NOBJNM	Object name in National Character Set
			QUAVEM	Quality of vertical measurement
			OBJNAM	Object name
			VERCOP	Vertical clearance, open
			HORCLR	Horizontal clearance
			COLOUR	Colour
			CATBRG	Category of bridge
			NATCON	Nature of construction
			CONDTN	Condition
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			DATSTA	Date, start
			VERCLR	Vertical clearance
			DATEND	Date, end
		B	INFORM	Information
			PICREP	Pictorial representation
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
BRTFAC	Berthing facility	A	DATEND	Date, end
			DATSTA	Date, start
			NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
			WATLEV	Water level effect
			CONDTN	Condition
		B	SCAMAX	Scale maximum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMIN	Scale minimum

Code	Object Class	Set	Attribute	Description
BRTFAC	Berthing facility	C	RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
			SORDAT	Source date
BUAARE	Built-up area	A	CONDTN	Condition
			VERDAT	Vertical datum
			CATBUA	Category of built-up area
			CONVIS	Conspicuous, visual
			HEIGHT	Height
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			CONRAD	Conspicuous, radar
			QUAVEM	Quality of vertical measurement
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
BUIREL	Building, religious	A	CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar
			BUISHP	Building shape
			CATREB	Category of religious building
			CONDTN	Condition
			HEIGHT	Height
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			QUAVEM	Quality of vertical measurement
			VERDAT	Vertical datum
			VERLEN	Vertical length
			COLOUR	Colour
			NATCON	Nature of construction
		B	SCAMAX	Scale maximum
			PICREP	Pictorial representation
			SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	SORDAT	Source date
			RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
BUISGL	Building, single	A	CONDTN	Condition
			NATCON	Nature of construction
			CONRAD	Conspicuous, radar
			CATBUI	Category of building, single
			VERLEN	Vertical length
			COLOUR	Colour
			VERDAT	Vertical datum
			HEIGHT	Height
			QUAVEM	Quality of vertical measurement
			BUISHP	Building shape
			OBJNAM	Object name
			COLPAT	Colour pattern
			NOBJNM	Object name in National Character Set
			CONVIS	Conspicuous, visual
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
			PICREP	Pictorial representation
		C	SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
			SORDAT	Source date
CAIRNS	Cairn	A	DATEND	Date, end
			STATUS	Status
			COLOUR	Colour
			COLPAT	Colour pattern
			CONDTN	Condition
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			VERLEN	Vertical length
			HEIGHT	Height

Code	Object Class	Set	Attribute	Description
CAIRNS	Cairn	A	NOBJNM	Object name in National Character Set
			VERDAT	Vertical datum
			QUAVEM	Quality of vertical measurement
			OBJNAM	Object name
			DATSTA	Date, start
		B	PICREP	Pictorial representation
			NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			INFORM	Information
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
CANALS	Canal	A	OBJNAM	Object name
			CONDTN	Condition
			DATEND	Date, end
			DATSTA	Date, start
			HORCLR	Horizontal clearance
			NOBJNM	Object name in National Character Set
			HORWID	Horizontal width
		B	SCAMIN	Scale minimum
			INFORM	Information
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
CANBNK	Canal bank	A	OBJNAM	Object name
			DATEND	Date, end
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
CAUSWY	Causeway	A	CONDTN	Condition
			NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
			WATLEV	Water level effect
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
CBLARE	Cable area	A	CATCBL	Category of cable
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
			DATEND	Date, end
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
CBLOHD	Cable, overhead	A	DATEND	Date, end
			CONDTN	Condition
			VERCSA	Vertical clearance, safe
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name

Code	Object Class	Set	Attribute	Description
CBLOHD	Cable. overhead	A	QUAVEM	Quality of vertical measurement
			STATUS	Status
			VERCLR	Vertical clearance
			CATCBL	Category of cable
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
CBLSUB	Cable. submarine	A	DATSTA	Date. start
			BURDEP	Buried depth
			CATCBL	Category of cable
			CONDTN	Condition
			DATEND	Date. end
			NOBJNM	Object name in National Character Set
			STATUS	Status
			OBJNAM	Object name
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	RECIND	Recording indication
			SORIND	Source indication
			RECDAT	Recording date
			SORDAT	Source date
CEMTRY	Cemetery	A	STATUS	Status
			OBJNAM	Object name
			CONDTN	Condition
			CONVIS	Conspicuous. visual
			NOBJNM	Object name in National Character Set
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
			SORDAT	Source date
CGUSTA	Coastguard station	A	DATSTA	Date. start
			OBJNAM	Object name
			STATUS	Status
			NOBJNM	Object name in National Character Set
			DATEND	Date. end
		B	NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			INFORM	Information
			SCAMAX	Scale maximum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
CHIMNY	Chimney	A	HEIGHT	Height
			VERDAT	Vertical datum
			QUAVEM	Quality of vertical measurement
			OBJNAM	Object name
			COLOUR	Colour
			NATCON	Nature of construction
			CONRAD	Conspicuous. radar
			CONVIS	Conspicuous. visual
			CONDTN	Condition
			COLPAT	Colour pattern
			VERLEN	Vertical length
			NOBJNM	Object name in National Character Set
		B	PICREP	Pictorial representation
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication

Code	Object Class	Set	Attribute	Description
CHKPNT	Checkpoint	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
			CATCHP	Category of checkpoint
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
CHNWIR	Chain/Wire	A	PERSTA	Periodic date, start
			STATUS	Status
			DATEND	Date, end
			PEREND	Periodic date, end
			DATSTA	Date, start
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
COALNE	Coastline	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			HEIGHT	Height
			CONRAD	Conspicuous, radar
			CATCOA	Category of coastline
			VERDAT	Vertical datum
			QUAVEM	Quality of vertical measurement
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
CONZNE	Contiguous zone	A	DATEND	Date, end
			STATUS	Status
			DATSTA	Date, start
			NATION	Nationality
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
COSARE	Continental shelf area	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			NATION	Nationality
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
			SORDAT	Source date
CRANES	Crane	A	QUAVEM	Quality of vertical measurement
			VERDAT	Vertical datum
			STATUS	Status
			RADIUS	Radius
			VERLEN	Vertical length
			ORIENT	Orientation
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			LIFCAP	Lifting capacity
			HEIGHT	Height
			CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar

Code	Object Class	Set	Attribute	Description
CRANES	Crane	A	CONDTN	Condition
			COLOUR	Colour
			CATCRN	Category of crane
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			PICREP	Pictorial representation
			INFORM	Information
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
CTNARE	Caution area	A	DATEND	Date, end
			DATSTA	Date, start
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
CTRPNT	Control point	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			CATCTR	Category of control point
			DATEND	Date, end
			HEIGHT	Height
			VERDAT	Vertical datum
			QUAVEM	Quality of vertical measurement
			DATSTA	Date, start
		B	NINFOM	Information in National Character Set
			INFORM	Information
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			PICREP	Pictorial representation
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
CTSARE	Cargo transhipment area	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			STATUS	Status
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
CUSZNE	Custom zone	A	NATION	Nationality
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
DAMCON	Dam	A	CONDTN	Condition
			NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	INFORM	Information
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
DEPARE	Depth area	A	DRVAL1	Depth range value 1
			VERDAT	Vertical datum
			DRVAL2	Depth range value 2
		B	SCAMAX	Scale maximum

Code	Object Class	Set	Attribute	Description
DEPARE	Depth area	B	SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
DEPCNT	Depth contour	A	VALDCO	Value of depth contour
			VERDAT	Vertical datum
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
DIFFUS	Diffuser	A	DATSTA	Date, start
			DATEND	Date, end
			EXPSOU	Exposition of sounding
			PRODCT	Product
			QUASOU	Quality of sounding measurement
			TECSOU	Technique of sounding measurement
			VALSOU	Value of sounding
			VERDAT	Vertical datum
			CONDTN	Condition
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	RECDAT	Recording date
			SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
DISMAR	Distance mark	A	CATDIS	Category of distance mark
			DATEND	Date, end
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
			SORDAT	Source date
DMPGRD	Dumping ground	A	STATUS	Status
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			CATDPG	Category of dumping ground
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
DOCARE	Dock area	A	CONDTN	Condition
			STATUS	Status
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			SORDAT	Source date
			RECDAT	Recording date
			RECIND	Recording indication
DRGARE	Dredged area	A	DRVAL2	Depth range value 2
			NOBJNM	Object name in National Character Set
			DRVAL1	Depth range value 1
			QUASOU	Quality of sounding measurement

Code	Object Class	Set	Attribute	Description
DRGARE	Dredged area	A	OBJNAM	Object name
			VERDAT	Vertical datum
			TECSOU	Technique of sounding measurement
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECIND	Recording indication
			RECDAT	Recording date
			SORDAT	Source date
			SORIND	Source indication
DRYDOC	Dry dock	A	NOBJNM	Object name in National Character Set
			CONDTN	Condition
			STATUS	Status
			HORCLR	Horizontal clearance
			OBJNAM	Object name
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
DSHAER	Dish aerial	A	CONDTN	Condition
			VERLEN	Vertical length
			VERDAT	Vertical datum
			QUAVEM	Quality of vertical measurement
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			HEIGHT	Height
			CONRAD	Conspicuous, radar
			COLOUR	Colour
			CONVIS	Conspicuous, visual
		B	INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
DUNARE	Dune	A	NATSUR	Nature of surface
			NOBJNM	Object name in National Character Set
			QUAVEM	Quality of vertical measurement
			NATQUA	Nature of surface, qualifying terms
			VERDAT	Vertical datum
			HEIGHT	Height
			CONVIS	Conspicuous, visual
			COLOUR	Colour
			CONRAD	Conspicuous, radar
			OBJNAM	Object name
		B	NINFOM	Information in National Character Set
			INFORM	Information
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
DWRTCL	Deep water route centreline	A	TECSOU	Technique of sounding measurement
			TRAFIC	Traffic flow
			DATSTA	Date, start
			DRVAL1	Depth range value 1
			CATTRK	Category of recommended track
			DRVAL2	Depth range value 2
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
			DATEND	Date, end
			QUASOU	Quality of sounding measurement
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set

Code	Object Class	Set	Attribute	Description
DWRTCL	Deep water route centreline	B	INFORM	Information
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
DWRTPT	Deep water route part	A	QUASOU	Quality of sounding measurement
			STATUS	Status
			ORIENT	Orientation
			DRVAL2	Depth range value 2
			DATSTA	Date, start
			DATEND	Date, end
			TECSOU	Technique of sounding measurement
			DRVAL1	Depth range value 1
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
DYKARE	Dyke area	A	CATDYK	Category of dyke
			CONDTN	Condition
			NATCON	Nature of construction
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
DYKCRW	Dyke crown	A	CATDYK	Category of dyke
			CONDTN	Condition
			CONRAD	Conspicuous, radar
			NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
EXEZNE	Exclusive economic zone	A	NATION	Nationality
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
			SORDAT	Source date
FAIRWY	Fairway	A	DATSTA	Date, start
			TRAFIC	Traffic flow
			TECSOU	Technique of sounding measurement
			STATUS	Status
			QUASOU	Quality of sounding measurement
			NOBJNM	Object name in National Character Set
			DRVAL1	Depth range value 1
			DRVAL2	Depth range value 2
			DATEND	Date, end
			OBJNAM	Object name
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
FERYRT	Ferry route	A	STATUS	Status
			CATFRY	Category of ferry

Code	Object Class	Set	Attribute	Description
FERYRT	Ferry route	A	PERSTA	Periodic date, start
			PEREND	Periodic date, end
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			DATSTA	Date, start
			DATEND	Date, end
		B	INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
FLASTK	Flare stack	A	VERDAT	Vertical datum
			VERLEN	Vertical length
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			CONVIS	Conspicuous, visual
			NOBJNM	Object name in National Character Set
			NATCON	Nature of construction
			HEIGHT	Height
			COLOUR	Colour
			CONDTN	Condition
			OBJNAM	Object name
			CONRAD	Conspicuous, radar
		B	SCAMIN	Scale minimum
			INFORM	Information
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
FLGSTF	Flagstaff/Flagpole	A	VERDAT	Vertical datum
			COLOUR	Colour
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			HEIGHT	Height
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			QUAVEM	Quality of vertical measurement
			VERLEN	Vertical length
		B	SCAMAX	Scale maximum
			PICREP	Pictorial representation
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
FLODOC	Floating dock	A	HORWID	Horizontal width
			HORLEN	Horizontal length
			HORCLR	Horizontal clearance
			CONDTN	Condition
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			LIFCAP	Lifting capacity
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
			VERLEN	Vertical length
			DATEND	Date, end
			DATSTA	Date, start
			COLOUR	Colour
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			PICREP	Pictorial representation
			INFORM	Information
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			SORDAT	Source date
			RECDAT	Recording date

Code	Object Class	Set	Attribute	Description
FLODOC	Floating dock	C	RECIND	Recording indication
FNCLNE	Fence	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			CATFNC	Category of fence
			COLOUR	Colour
			CONDTN	Condition
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			VERLEN	Vertical length
			NATCON	Nature of construction
		B	SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			INFORM	Information
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
FOGSIG	Fog signal	A	SIGGEN	Signal generation
			DATEND	Date, end
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			SIGFRQ	Signal frequency
			SIGGRP	Signal group
			SIGPER	Signal period
			SIGSEQ	Signal sequence
			STATUS	Status
			VALMXR	Value of maximum range
			VALNMR	Value of nominal range
			OBJNAM	Object name
			CATFOG	Category of fog signal
		B	INFORM	Information
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
FORSTC	Fortified structure	A	VERDAT	Vertical datum
			QUAVEM	Quality of vertical measurement
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar
			CONDTN	Condition
			CATFOR	Category of fortified structure
			NATCON	Nature of construction
			HEIGHT	Height
		B	INFORM	Information
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
FRPARE	Free port area	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
FSHFAC	Fishing facility	A	OBJNAM	Object name
			PERSTA	Periodic date, start
			CATFIF	Category of fishing facility
			NOBJNM	Object name in National Character Set
			PEREND	Periodic date, end
			STATUS	Status

Code	Object Class	Set	Attribute	Description
FSHFAC	Fishing facility	B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
FSHGRD	Fishing ground	A	OBJNAM	Object name
			PEREND	Periodic date, end
			PERSTA	Periodic date, start
			STATUS	Status
			NOBJNM	Object name in National Character Set
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECIND	Recording indication
			SORIND	Source indication
			SORDAT	Source date
			RECDAT	Recording date
FSHHAV	Fish haven	A	VERDAT	Vertical datum
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			QUASOU	Quality of sounding measurement
			TECSOU	Technique of sounding measurement
			VALSOU	Value of sounding
			EXPSOU	Exposition of sounding
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
FSHZNE	Fishery zone	A	NATION	Nationality
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
			SORIND	Source indication
GATCON	Gate	A	OBJNAM	Object name
			STATUS	Status
			NOBJNM	Object name in National Character Set
			NATCON	Nature of construction
			HORCLR	Horizontal clearance
			CONDTN	Condition
			CATGAT	Category of gate
			VERCLR	Vertical clearance
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
GRIDRN	Gridiron	A	HORLEN	Horizontal length
			HORWID	Horizontal width
			NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			VERLEN	Vertical length
			WATLEV	Water level effect
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum

Code	Object Class	Set	Attribute	Description
GRIDRN	Gridiron	C	SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
HILARE	Hill	A	VERDAT	Vertical datum
			CONVIS	Conspicuous, visual
			HEIGHT	Height
			NATQUA	Nature of surface, qualifying terms
			NATSUR	Nature of surface
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			CONRAD	Conspicuous, radar
			QUAVEM	Quality of vertical measurement
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
			SORDAT	Source date
HRBARE	Harbour area (administrative)	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			RECIND	Recording indication
			SORIND	Source indication
			RECDAT	Recording date
HRBFAC	Harbour facility	A	STATUS	Status
			OBJNAM	Object name
			NATCON	Nature of construction
			DATSTA	Date, start
			DATEND	Date, end
			CONDTN	Condition
			CATHAF	Category of harbour facility
			PEREND	Periodic date, end
			PERSTA	Periodic date, start
			NOBJNM	Object name in National Character Set
		B	NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			INFORM	Information
		C	SORDAT	Source date
			RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
HULKES	Hulk	A	COLOUR	Colour
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			HORWID	Horizontal width
			HORLEN	Horizontal length
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
		B	INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
ICEARE	Ice area	A	CONVIS	Conspicuous, visual
			VERDAT	Vertical datum
			STATUS	Status
			PERSTA	Periodic date, start
			PEREND	Periodic date, end
			OBJNAM	Object name
			HEIGHT	Height
			CATICE	Category of ice
			NOBJNM	Object name in National Character Set

Code	Object Class	Set	Attribute	Description
ICEARE	Ice area	B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
ICNARE	Incineration area	A	STATUS	Status
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
ITDARE	Intertidal area	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			NATQUA	Nature of surface, qualifying terms
			NATSUR	Nature of surface
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
LAKARE	Lake	A	VERDAT	Vertical datum
			QUAVEM	Quality of vertical measurement
			OBJNAM	Object name
			HEIGHT	Height
			NOBJNM	Object name in National Character Set
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
LAKSHR	Lake shore	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
LIGHTS	Light	A	SECTR1	Sectorlimit one
			SECTR2	Sectorlimit two
			QUAVEM	Quality of vertical measurement
			VERDAT	Vertical datum
			SIGGRP	Signal group
			SIGPER	Signal period
			SIGSEQ	Signal sequence
			STATUS	Status
			VALNMR	Value of nominal range
			HEIGHT	Height
			PERSTA	Periodic date, start
			SUPLIT	Supervision of light
			DATEND	Date, end
			PEREND	Periodic date, end
			LITVIS	Light visibility
			COLOUR	Colour
			DATSTA	Date, start
			EXCLIT	Exhibition condition of light
			LITCHR	Light characteristic
			MARSYS	Marks navigational - System of
			NOBJNM	Object name in National Character Set

Code	Object Class	Set	Attribute	Description
LIGHTS	Light	A	OBJNAM	Object name
			ORIENT	Orientation
			CATLIT	Category of light
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
LITFLT	Light float	A	VERLEN	Vertical length
			QUAVEM	Quality of vertical measurement
			PERSTA	Periodic date, start
			PEREND	Periodic date, end
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			HORLEN	Horizontal length
			DATEND	Date, end
			CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar
			COLPAT	Colour pattern
			COLMAR	Colour of navigational mark
			HORWID	Horizontal width
			MARSYS	Marks navigational - System of
			DATSTA	Date, start
		B	INFORM	Information
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
			SORDAT	Source date
LITMOI	Light, moiré effect	A	ORIENT	Orientation
			COLOUR	Colour
			VALNMR	Value of nominal range
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			PERSTA	Periodic date, start
			PEREND	Periodic date, end
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			HEIGHT	Height
			DATEND	Date, end
			VERDAT	Vertical datum
			DATSTA	Date, start
		B	NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
LITVES	Light vessel	A	DATEND	Date, end
			QUAVEM	Quality of vertical measurement
			PEREND	Periodic date, end
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			VERLEN	Vertical length
			MARSYS	Marks navigational - System of
			PERSTA	Periodic date, start
			HORWID	Horizontal width
			DATSTA	Date, start
			CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar
			COLPAT	Colour pattern
			COLMAR	Colour of navigational mark
			HORLEN	Horizontal length
		B	SCAMIN	Scale minimum
			INFORM	Information
			SCAMAX	Scale maximum

Code	Object Class	Set	Attribute	Description
LITVES	Light vessel	B	PICREP	Pictorial representation
			NINFOM	Information in National Character Set
		C	SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
			SORDAT	Source date
LNDARE	Land area	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
LNDELV	Land elevation	A	HEIGHT	Height
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			QUAVEM	Quality of vertical measurement
			VERDAT	Vertical datum
			CONVIS	Conspicuous, visual
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
LNDPLC	Landing place	A	CONDTN	Condition
			WATLEV	Water level effect
			STATUS	Status
			OBJNAM	Object name
			NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
		B	INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
LNDRGN	Land region	A	NATQUA	Nature of surface, qualifying terms
			NATSUR	Nature of surface
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			CATLND	Category of land region
		B	INFORM	Information
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
		C	SORIND	Source indication
			SORDAT	Source date
			RECDAT	Recording date
			RECIND	Recording indication
LNDSTS	Landing stairs	A	VERLEN	Vertical length
			NATCON	Nature of construction
			CONDTN	Condition
			QUAVEM	Quality of vertical measurement
			WATLEV	Water level effect
		B	INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
LOCMAG	Local magnetic anomaly	A	NOBJNM	Object name in National Character Set
			VALLMA	Value of local magnetic anomaly
			OBJNAM	Object name
		B	INFORM	Information
			NINFOM	Information in National Character Set

Code	Object Class	Set	Attribute	Description
LOCMAG	Local magnetic anomaly	B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
		C	SORIND	Source indication
			RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
LOGPON	Log pond	A	STATUS	Status
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
LOKBSN	Lock basin	A	STATUS	Status
			DATEND	Date, end
			DATSTA	Date, start
			HORCLR	Horizontal clearance
			HORWID	Horizontal width
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			HORLEN	Horizontal length
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
M_ACCY	Accuracy of data	A	HORACC	Horizontal accuracy
			VERACC	Vertical accuracy
		B	NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
			SORDAT	Source date
MARCUL	Marine farm/culture	A	NOBJNM	Object name in National Character Set
			DATEND	Date, end
			WATLEV	Water level effect
			STATUS	Status
			PERSTA	Periodic date, start
			OBJNAM	Object name
			DATSTA	Date, start
			CATMFA	Category of marine farm/culture
			PEREND	Periodic date, end
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
MIPARE	Military practice area	A	STATUS	Status
			CATMPA	Category of military practice area
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
MONUMT	Monument	A	COLOUR	Colour
			CATMNT	Category of monument
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			HEIGHT	Height

Code	Object Class	Set	Attribute	Description
MONUMT	Monument	A	NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			QUAVEM	Quality of vertical measurement
			VERDAT	Vertical datum
			VERLEN	Vertical length
			BUISHP	Building shape
			CONDTN	Condition
		B	PICREP	Pictorial representation
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
MORFAC	Mooring/Warping facility	A	CATMOR	Category of mooring/warping facility
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			STATUS	Status
			PERSTA	Periodic date, start
			NATCON	Nature of construction
			PEREND	Periodic date, end
			DATSTA	Date, start
			DATEND	Date, end
			CONRAD	Conspicuous, radar
			CONDTN	Condition
			COLOUR	Colour
		B	PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	SORIND	Source indication
			RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
MSTCON	Mast	A	CONRAD	Conspicuous, radar
			QUAVEM	Quality of vertical measurement
			CATMST	Category of mast
			COLOUR	Colour
			COLPAT	Colour pattern
			CONVIS	Conspicuous, visual
			HEIGHT	Height
			OBJNAM	Object name
			VERDAT	Vertical datum
			VERLEN	Vertical length
			NOBJNM	Object name in National Character Set
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
NATARE	National territorial area	A	NATION	Nationality
		B	SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
NAVLNE	Navigation line	A	PERSTA	Periodic date, start
			PEREND	Periodic date, end
			ORIENT	Orientation
			DATSTA	Date, start
			DATEND	Date, end
			CATNAV	Category of navigation line
			STATUS	Status
		B	SCAMAX	Scale maximum

Code	Object Class	Set	Attribute	Description
NAVLNE	Navigation line	B	SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
OBSTRN	Obstruction	A	EXPSOU	Exposition of sounding
			WATLEV	Water level effect
			VERDAT	Vertical datum
			VALSOU	Value of sounding
			TECSOU	Technique of sounding measurement
			QUASOU	Quality of sounding measurement
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
OFSPLF	Offshore platform	A	CONDTN	Condition
			COLPAT	Colour pattern
			CATOFP	Category of offshore platform
			COLOUR	Colour
			CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			PRODCT	Product
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			HEIGHT	Height
			DATSTA	Date, start
			DATEND	Date, end
			VERDAT	Vertical datum
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
OFSPRD	Offshore production area	A	PRODCT	Product
			CONDTN	Condition
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
			DATEND	Date, end
		B	SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
			SCAMAX	Scale maximum
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
OILBAR	Oil barrier	A	CATOLB	Category of oil barrier
			CONDTN	Condition
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			DATEND	Date, end
			OBJNAM	Object name
			STATUS	Status
		B	SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			INFORM	Information
		C	SORIND	Source indication
			SORDAT	Source date

Code	Object Class	Set	Attribute	Description
OILBAR	Oil barrier	C	RECIND	Recording indication
			RECDAT	Recording date
PILBOP	Pilot boarding place	A	COMCHA	Communication channel
			PILDST	Pilot district
			OBJNAM	Object name
			STATUS	Status
			NPLDST	Pilot District in National Character Set
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			CATPIL	Category of pilot boarding place
			DATEND	Date, end
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
PILPNT	Pile	A	VALSOU	Value of sounding
			VERDAT	Vertical datum
			TECSOU	Technique of sounding measurement
			QUAVEM	Quality of vertical measurement
			QUASOU	Quality of sounding measurement
			HEIGHT	Height
			EXPSOU	Exposition of sounding
			DATSTA	Date, start
			DATEND	Date, end
			CONDTN	Condition
			CATPLE	Category of pile
			VERLEN	Vertical length
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
			SORDAT	Source date
PINGOS	Pingo	A	VERLEN	Vertical length
			NATQUA	Nature of surface, qualifying terms
			CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar
			EXPSOU	Exposition of sounding
			WATLEV	Water level effect
			VERDAT	Vertical datum
			VALSOU	Value of sounding
			TECSOU	Technique of sounding measurement
			QUAVEM	Quality of vertical measurement
			QUASOU	Quality of sounding measurement
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			NATSUR	Nature of surface
			HEIGHT	Height
		B	INFORM	Information
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
PIPARE	Pipeline area	A	STATUS	Status
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			DATSTA	Date, start
			DATEND	Date, end
			CONDTN	Condition
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication

Code	Object Class	Set	Attribute	Description
PIPARE	Pipeline area	C	RECDAT	Recording date
PIPOHD	Pipeline, overhead	A	VERCLR	Vertical clearance
			CATPIP	Category of pipeline/pipe
			VERDAT	Vertical datum
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			PRODCT	Product
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			DATSTA	Date, start
			DATEND	Date, end
			CONDTN	Condition
		B	INFORM	Information
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	RECIND	Recording indication
			SORIND	Source indication
			SORDAT	Source date
			RECDAT	Recording date
PIPSOL	Pipeline, submarine/on land	A	BURDEP	Buried depth
			CONDTN	Condition
			DATSTA	Date, start
			CATPIP	Category of pipeline/pipe
			DATEND	Date, end
			STATUS	Status
			PRODCT	Product
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
			SCAMIN	Scale minimum
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
PONTON	Pontoon	A	STATUS	Status
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			CONDTN	Condition
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			DATEND	Date, end
			DATSTA	Date, start
			PEREND	Periodic date, end
			NATCON	Nature of construction
			PERSTA	Periodic date, start
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
PRCARE	Precautionary area	A	DATEND	Date, end
			DATSTA	Date, start
			STATUS	Status
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
			SORDAT	Source date
PRDINS	Production installation	A	QUASOU	Quality of sounding measurement
			WATLEV	Water level effect
			VERDAT	Vertical datum
			VALSOU	Value of sounding
			TECSOU	Technique of sounding measurement
			QUAVEM	Quality of vertical measurement
			PRODCT	Product
			OBJNAM	Object name

Code	Object Class	Set	Attribute	Description
PRDINS	Production installation	A	NOBJNM	Object name in National Character Set
			HEIGHT	Height
			EXPSOU	Exposition of sounding
			DATSTA	Date, start
			DATEND	Date, end
			CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar
			CONDTN	Condition
			CATPRI	Category of production installation
			STATUS	Status
		B	SCAMAX	Scale maximum
			INFORM	Information
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
PYLONS	Pylon	A	VERLEN	Vertical length
			QUAVEM	Quality of vertical measurement
			COLOUR	Colour
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			NATCON	Nature of construction
			HEIGHT	Height
			CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar
			CONDTN	Condition
			COLPAT	Colour pattern
			VERDAT	Vertical datum
		B	NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			PICREP	Pictorial representation
			INFORM	Information
		C	RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
RADDOM	Radar dome	A	RADIUS	Radius
			VERDAT	Vertical datum
			QUAVEM	Quality of vertical measurement
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			HEIGHT	Height
			CONVIS	Conspicuous, visual
			CONRAD	Conspicuous, radar
			CONDTN	Condition
			COLOUR	Colour
			VERLEN	Vertical length
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
RADLNE	Radar line	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			ORIENT	Orientation
			STATUS	Status
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
		C	RECIND	Recording indication
			RECDAT	Recording date
			SORDAT	Source date
			SORIND	Source indication
RADRFL	Radar reflector	A	VERDAT	Vertical datum
			STATUS	Status
			HEIGHT	Height

Code	Object Class	Set	Attribute	Description
RADRFL	Radar reflector	A	QUAVEM	Quality of vertical measurement
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
RADRNG	Radar range	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			COMCHA	Communication channel
			STATUS	Status
			DATEND	Date, end
			DATSTA	Date, start
		B	NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			INFORM	Information
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
RADSTA	Radar station	A	VALNMR	Value of nominal range
			STATUS	Status
			QUAVEM	Quality of vertical measurement
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			HEIGHT	Height
			DATSTA	Date, start
			CATRAS	Category of radar station
			VERDAT	Vertical datum
			DATEND	Date, end
		B	INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
RAILWY	Railway	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			CONDTN	Condition
			STATUS	Status
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
RAPIDS	Rapids	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			VERLEN	Vertical length
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
RCRTCL	Recommended route centreline	A	DATEND	Date, end
			DATSTA	Date, start
			TRAFIC	Traffic flow
			CATTRK	Category of recommended track
			DRVAL1	Depth range value 1
			DRVAL2	Depth range value 2
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			QUASOU	Quality of sounding measurement
			STATUS	Status
			TECSOU	Technique of sounding measurement

Code	Object Class	Set	Attribute	Description
RCRTCL	Recommended route centreline	B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
RCTLPT	Recommended traffic lane part	A	STATUS	Status
			DATEND	Date, end
			ORIENT	Orientation
			DATSTA	Date, start
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
RDOCAL	Radio calling-in point	A	DATEND	Date, end
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			ORIENT	Orientation
			PEREND	Periodic date, end
			PERSTA	Periodic date, start
			STATUS	Status
			TRAFIC	Traffic flow
			COMCHA	Communication channel
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	SORDAT	Source date
			RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
RDOSTA	Radio station	A	NOBJNM	Object name in National Character Set
			CATROS	Category of radio station
			STATUS	Status
			SIGFRQ	Signal frequency
			PERSTA	Periodic date, start
			OBJNAM	Object name
			ESTRNG	Estimated range of transmission
			DATSTA	Date, start
			DATEND	Date, end
			PEREND	Periodic date, end
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
RECTRC	Recommended track	A	DRVAL2	Depth range value 2
			DATSTA	Date, start
			DATEND	Date, end
			CATTRK	Category of recommended track
			DRVAL1	Depth range value 1
			QUASOU	Quality of sounding measurement
			PERSTA	Periodic date, start
			PEREND	Periodic date, end
			ORIENT	Orientation
			NOBJNM	Object name in National Character Set
			TECSOU	Technique of sounding measurement
			TRAFIC	Traffic flow
			STATUS	Status
			OBJNAM	Object name
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
		C	SORIND	Source indication

Code	Object Class	Set	Attribute	Description
RECTRC	Recommended track	C	RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
RESARE	Restricted area	A	STATUS	Status
			DATEND	Date, end
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			PEREND	Periodic date, end
			PERSTA	Periodic date, start
			CATREA	Category of restricted area
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	SORDAT	Source date
			RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
RIVBNK	River bank	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
			SORDAT	Source date
RIVERS	River	A	STATUS	Status
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
RMPARE	Ramp	A	OBJNAM	Object name
			STATUS	Status
			NOBJNM	Object name in National Character Set
			NATCON	Nature of construction
			HORWID	Horizontal width
			HORLEN	Horizontal length
			HORCLR	Horizontal clearance
			WATLEV	Water level effect
			CONDTN	Condition
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
			SORDAT	Source date
ROADPT	Road part	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			CATROD	Category of road
			NATCON	Nature of construction
			CONDTN	Condition
			STATUS	Status
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
			SORIND	Source indication
RODCRS	Road crossing	A	STATUS	Status
			CONDTN	Condition
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set

Code	Object Class	Set	Attribute	Description
RODCRS	Road crossing	A	NATCON	Nature of construction
			CATROD	Category of road
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
RSCSTA	Rescue station	A	DATEND	Date, end
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
			CATRSC	Category of rescue station
		B	NINFOM	Information in National Character Set
			INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
RTPBCN	Radar transponder beacon	A	STATUS	Status
			CATRTB	Category of radar transponder beacon
			DATEND	Date, end
			SECTR1	Sectorlimit one
			VALMXR	Value of maximum range
			SIGSEQ	Signal sequence
			SIGGRP	Signal group
			SECTR2	Sectorlimit two
			NOBJNM	Object name in National Character Set
			RADWAL	Radar transponder beacon wavelength
			OBJNAM	Object name
			DATSTA	Date, start
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORDAT	Source date
			RECIND	Recording indication
			SORIND	Source indication
			RECDAT	Recording date
RUNWAY	Runway	A	OBJNAM	Object name
			NATCON	Nature of construction
			CONVIS	Conspicuous, visual
			NOBJNM	Object name in National Character Set
			STATUS	Status
			CONDTN	Condition
		B	SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
			SCAMAX	Scale maximum
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
SBDARE	Seabed area	A	NATQUA	Nature of surface, qualifying terms
			NATSUR	Nature of surface
			COLOUR	Colour
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
SEAARE	Sea area	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			CATSEA	Category of sea area
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum

Code	Object Class	Set	Attribute	Description
SEAARE	Sea area	B	SCAMIN	Scale minimum
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
SILBUI	Silo	A	NOBJNM	Object name in National Character Set
			CONRAD	Conspicuous, radar
			BUISHP	Building shape
			VERLEN	Vertical length
			COLPAT	Colour pattern
			CONDTN	Condition
			COLOUR	Colour
			CONVIS	Conspicuous, visual
			NATCON	Nature of construction
			OBJNAM	Object name
			PRODCT	Product
			QUAVEM	Quality of vertical measurement
			VERDAT	Vertical datum
			HEIGHT	Height
		B	INFORM	Information
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
SISTAT	Signal station, traffic	A	STATUS	Status
			OBJNAM	Object name
			PERSTA	Periodic date, start
			PEREND	Periodic date, end
			COMCHA	Communication channel
			DATEND	Date, end
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			CATSIT	Category of signal station, traffic
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			RECDAT	Recording date
			SORDAT	Source date
			RECIND	Recording indication
SISTAW	Signal station, warning	A	COMCHA	Communication channel
			DATEND	Date, end
			DATSTA	Date, start
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			PEREND	Periodic date, end
			PERSTA	Periodic date, start
			STATUS	Status
			CATSIW	Category of signal station, warning
		B	SCAMIN	Scale minimum
			INFORM	Information
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
SLCONS	Shoreline construction	A	QUAVEM	Quality of vertical measurement
			NOBJNM	Object name in National Character Set
			CONDTN	Condition
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			DATEND	Date, end
			DATSTA	Date, start
			VERDAT	Vertical datum
			NATCON	Nature of construction
			OBJNAM	Object name
			STATUS	Status
			CATSLC	Category of shoreline construction
			VERLEN	Vertical length

Code	Object Class	Set	Attribute	Description
SLCONS	Shoreline construction	A	WATLEV	Water level effect
			HEIGHT	Height
		B	SCAMAX	Scale maximum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
			RECIND	Recording indication
SLIPWY	Slipway	A	OBJNAM	Object name
			HORCLR	Horizontal clearance
			HORLEN	Horizontal length
			HORWID	Horizontal width
			CONDTN	Condition
			NOBJNM	Object name in National Character Set
			WATLEV	Water level effect
			STATUS	Status
			NATCON	Nature of construction
		B	INFORM	Information
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
SLOGRD	Sloping ground	A	WATLEV	Water level effect
			CONDTN	Condition
			NATCON	Nature of construction
			NATSUR	Nature of surface
			NATQUA	Nature of surface, qualifying terms
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
SLOTOP	Slope topline	A	VERDAT	Vertical datum
			QUAVEM	Quality of vertical measurement
			CONRAD	Conspicuous, radar
			HEIGHT	Height
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
SLTPAN	Salt pan	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
SMCFAC	Small craft facility	A	CONDTN	Condition
			CONVIS	Conspicuous, visual
			COLPAT	Colour pattern
			HEIGHT	Height
			CONRAD	Conspicuous, radar
			COLOUR	Colour
			NOBJNM	Object name in National Character Set
			VERLEN	Vertical length
			CATSCF	Category of small craft facility
			NATCON	Nature of construction
			OBJNAM	Object name
			QUAVEM	Quality of vertical measurement
			VERDAT	Vertical datum

Code	Object Class	Set	Attribute	Description
SMCFAC	Small craft facility	A	BUISHP	Building shape
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
SNDWAV	Sand waves	B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
SOUNDG	Sounding	A	NOBJNM	Object name in National Character Set
			TECSOU	Technique of sounding measurement
			QUASOU	Quality of sounding measurement
			OBJNAM	Object name
			VERDAT	Vertical datum
			EXPSOU	Exposition of sounding
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
			SORIND	Source indication
SPLARE	Sea-plane landing area	A	STATUS	Status
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
SPOGRD	Spoil ground	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			STATUS	Status
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECDAT	Recording date
			SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
SPRING	Spring	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
SQUARE	Square	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			NATCON	Nature of construction
			CONDTN	Condition
			STATUS	Status
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORDAT	Source date
			RECIND	Recording indication

Code	Object Class	Set	Attribute	Description
SQUARE	Square	C	SORIND	Source indication
			RECDAT	Recording date
STSLNE	Straight territorial sea baseline	A	NATION	Nationality
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
SUBTLN	Submarine transit lane	A	NOBJNM	Object name in National Character Set
			OBJNAM	Object name
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
TELPHC	Telepheric	A	LIFCAP	Lifting capacity
			STATUS	Status
			VERCLR	Vertical clearance
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			CONDTN	Condition
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			QUAVEM	Quality of vertical measurement
			DATSTA	Date, start
			DATEND	Date, end
		B	SCAMIN	Scale minimum
			INFORM	Information
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
TESARE	Territorial sea area	A	NATION	Nationality
		B	INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
TIDEWY	Tideway	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
TNKCON	Tank	A	HEIGHT	Height
			CONDTN	Condition
			PRODCT	Product
			COLOUR	Colour
			NOBJNM	Object name in National Character Set
			CONRAD	Conspicuous, radar
			OBJNAM	Object name
			VERLEN	Vertical length
			VERDAT	Vertical datum
			COLPAT	Colour pattern
			QUAVEM	Quality of vertical measurement
			CONVIS	Conspicuous, visual
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set

Code	Object Class	Set	Attribute	Description
TNKCON	Tank	B	INFORM	Information
		C	SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
			SORDAT	Source date
TNLENT	Tunnel entrance	A	VERCLR	Vertical clearance
			OBJNAM	Object name
			HORCLR	Horizontal clearance
			NOBJNM	Object name in National Character Set
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
TOPMAR	Top mark	A	VERDAT	Vertical datum
			COLMAR	Colour of navigational mark
			COLPAT	Colour pattern
			HEIGHT	Height
			MARSYS	Marks navigational - System of
			QUAVEM	Quality of vertical measurement
			STATUS	Status
			TOPSHP	Top mark shape
			VERLEN	Vertical length
		B	SCAMIN	Scale minimum
			NINFOM	Information in National Character Set
			INFORM	Information
			SCAMAX	Scale maximum
			PICREP	Pictorial representation
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
TOWERS	Tower	A	QUAVEM	Quality of vertical measurement
			CONRAD	Conspicuous, radar
			CONVIS	Conspicuous, visual
			HEIGHT	Height
			NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			VERDAT	Vertical datum
			VERLEN	Vertical length
			CONDTN	Condition
			CATTOW	Category of tower
			COLPAT	Colour pattern
			COLOUR	Colour
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			INFORM	Information
			PICREP	Pictorial representation
			NINFOM	Information in National Character Set
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
TREPNT	Tree	A	CONVIS	Conspicuous, visual
			VERDAT	Vertical datum
			CATTRE	Category of tree
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			QUAVEM	Quality of vertical measurement
			VERLEN	Vertical length
			HEIGHT	Height
		B	SCAMIN	Scale minimum
			INFORM	Information
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
TSELNE	Traffic separation line	A	STATUS	Status
			DATSTA	Date, start

Code	Object Class	Set	Attribute	Description
TSELNE	Traffic separation line	A	DATEND	Date. end
			CATTSS	Category of Traffic Separation Scheme
		B	NINFOM	Information in National Character Set
			INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
		C	SORDAT	Source date
			RECIND	Recording indication
			SORIND	Source indication
			RECDAT	Recording date
TSEZNE	Traffic separation zone	A	CATTSS	Category of Traffic Separation Scheme
			STATUS	Status
			DATEND	Date. end
			DATSTA	Date. start
		B	INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
TSSBND	Traffic separation scheme bound	A	CATTSS	Category of Traffic Separation Scheme
			DATSTA	Date. start
			STATUS	Status
			DATEND	Date. end
		B	SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			SCAMIN	Scale minimum
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
TSSCRS	Traffic separation scheme crossi	A	CATTSS	Category of Traffic Separation Scheme
			DATEND	Date. end
			DATSTA	Date. start
			STATUS	Status
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	SORIND	Source indication
			RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
TSSLPT	Traffic separation scheme lane p	A	STATUS	Status
			ORIENT	Orientation
			DATEND	Date. end
			DATSTA	Date. start
			CATTSS	Category of Traffic Separation Scheme
		B	SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
			SORDAT	Source date
TSSRON	Traffic separation scheme round	A	DATSTA	Date. start
			DATEND	Date. end
			STATUS	Status
			CATTSS	Category of Traffic Separation Scheme
		B	INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
TWRTPT	Two-way route part	A	DATSTA	Date. start
			CATTRK	Category of recommended track
			STATUS	Status
			TECSOU	Technique of sounding measurement

Code	Object Class	Set	Attribute	Description
TWRTPT	Two-way route part	A	ORIENT	Orientation
			DRVAL1	Depth range value 1
			DATEND	Date, end
			QUASOU	Quality of sounding measurement
			DRVAL2	Depth range value 2
		B	SCAMIN	Scale minimum
			INFORM	Information
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
		C	SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
			SORIND	Source indication
UWTROC	Underwater rock	A	QUASOU	Quality of sounding measurement
			VERDAT	Vertical datum
			TECSOU	Technique of sounding measurement
			WATLEV	Water level effect
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			EXPSOU	Exposition of sounding
			VALSOU	Value of sounding
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			INFORM	Information
			NINFOM	Information in National Character Set
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date
VEGARE	Vegetation area	A	CATVEG	Category of vegetation
			CONVIS	Conspicuous, visual
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	SORDAT	Source date
			RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
WATFAL	Waterfall	A	VERLEN	Vertical length
			QUAVEM	Quality of vertical measurement
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
			CONVIS	Conspicuous, visual
		B	NINFOM	Information in National Character Set
			INFORM	Information
			SCAMIN	Scale minimum
			SCAMAX	Scale maximum
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORIND	Source indication
			SORDAT	Source date
WATTUR	Water turbulence	A	CATWAT	Category of water turbulence
			OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
WEDKLP	Weed/Kelp	A	OBJNAM	Object name
			NOBJNM	Object name in National Character Set
		B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
WIMCON	Windmotor	A	VERLEN	Vertical length
			CONRAD	Conspicuous, radar

Code	Object Class	Set	Attribute	Description
WIMCON	Windmotor	A	HEIGHT	Height
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			VERDAT	Vertical datum
			CONDTN	Condition
			COLOUR	Colour
			QUAVEM	Quality of vertical measurement
			CONVIS	Conspicuous, visual
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
		C	SORIND	Source indication
			RECIND	Recording indication
			SORDAT	Source date
			RECDAT	Recording date
WIRLNE	Weir	A	CONDTN	Condition
			DATEND	Date, end
			DATSTA	Date, start
			NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			QUAVEM	Quality of vertical measurement
			VERLEN	Vertical length
		B	SCAMIN	Scale minimum
			INFORM	Information
			NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
WNDMIL	Windmill	A	VERLEN	Vertical length
			CONRAD	Conspicuous, radar
			COLOUR	Colour
			CONVIS	Conspicuous, visual
			HEIGHT	Height
			NATCON	Nature of construction
			NOBJNM	Object name in National Character Set
			OBJNAM	Object name
			QUAVEM	Quality of vertical measurement
			VERDAT	Vertical datum
			CONDTN	Condition
		B	NINFOM	Information in National Character Set
			PICREP	Pictorial representation
			SCAMAX	Scale maximum
			SCAMIN	Scale minimum
			INFORM	Information
		C	RECDAT	Recording date
			RECIND	Recording indication
			SORDAT	Source date
			SORIND	Source indication
WRECKS	Wreck	A	VERDAT	Vertical datum
			WATLEV	Water level effect
			OBJNAM	Object name
			CONVIS	Conspicuous, visual
			VALSOU	Value of sounding
			CATWRK	Category of wreck
			QUASOU	Quality of sounding measurement
			EXPSOU	Exposition of sounding
			CONRAD	Conspicuous, radar
			NOBJNM	Object name in National Character Set
			QUAVEM	Quality of vertical measurement
			TECSOU	Technique of sounding measurement
			HEIGHT	Height
		B	SCAMIN	Scale minimum
			SCAMAX	Scale maximum
			NINFOM	Information in National Character Set
			INFORM	Information
		C	SORDAT	Source date
			SORIND	Source indication
			RECIND	Recording indication
			RECDAT	Recording date
ZEMCNT	Zero meter - contour	A	VERDAT	Vertical datum

Code	Object Class	Set	Attribute	Description
ZEMCNT	Zero meter - contour	B	NINFOM	Information in National Character Set
			SCAMAX	Scale maximum
			INFORM	Information
			SCAMIN	Scale minimum
		C	SORIND	Source indication
			SORDAT	Source date
			RECIND	Recording indication
			RECDAT	Recording date

APPENDIX H - DATABASE SCHEMA (February 1997)

Figure H. 1 Chart Correction Schema A

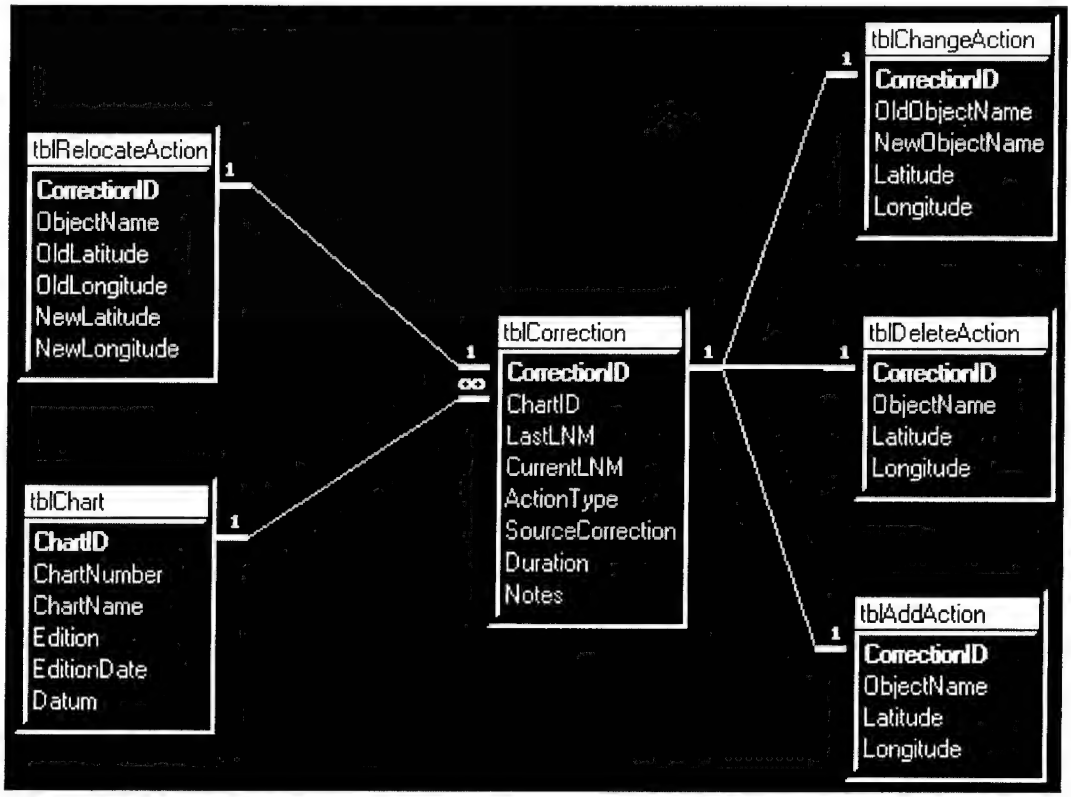
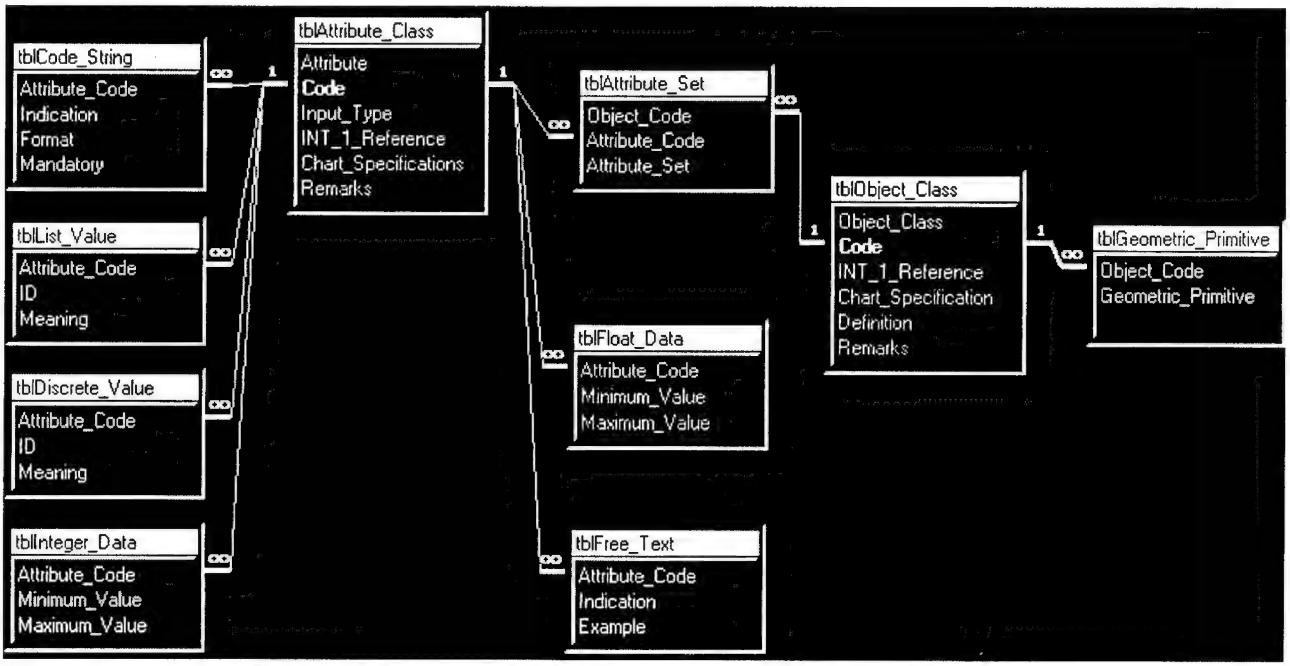


Figure H. 2 S57 Version 2 Schema B



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APPENDIX I - DESCRIPTION OF THE ECU FORMAT AND EXAMPLES OF ECU ACTIONS (JUNE 1997)

Format of ECU

The format of an ECU uses the S57 object and attribute definitions to fully describe the object. All of the objects and attribute definitions can be found in the IHO Transfer Standard for Digital Hydrographic Data Edition 3.0 - March 1996 Special Publication No. 57. The six (6) character acronyms defined in IHO Object Catalog (S57 Appendix A) are used to describe each object. For example:

Object Acronym	Object Definition
BCNCAR	Beacon, cardinal
BOYLAT	Buoy, lateral
LIGHTS	Light
LNDMRK	Landmark

Also, the six (6) character acronyms defined in IHO Attributes (S57 Appendix A - Chapter 2) are used to describe each attribute. For example for the lateral buoy (BOYLAT) object, some of the following attributes would be used:

Attribute Acronym	Attribute Definition
OBJNAM	Object Name
BOYSHP	Buoy Shape
CATLAM	Category of lateral mark
COLOUR	Color
COLPAT	Color Pattern

The values of the attributes will also be encoded as described in the Attribute section of S57 (Appendix A - Chapter 2). The location of an object, in S57 tied to a spatial object, will be given by the newly introduced LOCATE attribute.

The actions currently used in the LNM (Add, Delete, Relocate and Change) will no longer be used, the S57 updating actions will be used instead (INSERT, DELETE and MODIFY). Each of these actions is six (6) characters, again making the correction easy for the computer to parse. Since S57 differentiates between feature and spatial objects, the MODIFY action will only be used to indicate an object attribute has changed (i.e. COLOUR from "green" to "red"). An additional action RLOCAT (relocate) will be used to indicate that the object has moved (the spatial object has been modified). The following table shows the relationships between the LNM and ECU actions:

LNM Action	ECU Action
Add	INSERT
Delete	DELETE
Change/Substitute	MODIFY
Relocate	RLOCAT

The basic format for an ECU Chart Corrections is as follows:

```
ECU Action
<tab> Object Acronym
<tab> <tab> Attribute Acronym  <tab> Attribute Value
                  ...
<tab> <tab> Attribute Acronym  <tab> Attribute Value
```

Note that the ECU Action always starts in column 1. All lines will end with a carriage return and line feed combination. Blank lines will separate differing corrections. The OBJNAM attribute will ALWAYS be the first attribute in the list, followed by the LOCATE attribute.

The ECU INSERT Action

The INSERT action is structured as follows:

```
INSERT
<tab> Object Acronym
<tab> <tab> OBJNAM                    <tab> Name of object
<tab> <tab> LOCATE                    <tab> latitude, longitude
<tab> <tab> Attribute Acronym         <tab> Attribute Value
<tab> <tab> Attribute Acronym         <tab> Attribute Value
        .              ...
```

An simple example of adding a special purpose/general buoy (BOYSPP) follows:

```
INSERT
      BOY   SPP
            OBJNAM      Mackerel Cove Buoy 1
            LOCATE      43²43'24.6"N 070²00'20.0"W
            COLOUR      green
```

The ECU DELETE Action

The DELETE action is structured as follows:

```
DELETE
<tab> Object Acronym
<tab> <tab> OBJNAM                    <tab> Name of object
<tab> <tab> LOCATE                    <tab> latitude, longitude
<tab> <tab> Attribute Acronym         <tab> Attribute Value
<tab> <tab> Attribute Acronym         <tab> Attribute Value
                        ...
```

An simple example of deleting the buoy added above would be:

```
DELETE
      BOY   SPP
            OBJNAM      Mackerel Cove Buoy 1
            LOCATE      43²43'24.6"N 070²00'20.0"W
```

```
COLOUR      green
```

Sometimes, ATONIS or an ENC for the area will have more information about the buoy be affected than the LNM has. If this is the case, these attributes will be added to the information supplied. For example, if ATONIS or an ENC indicates that the buoy is a can/cylindrical buoy with horizontal stripes, the information would have looked something like this:

```
DELETE
      BOY   SPP
            OBJNAM      Mackerel Cove Buoy 1
            LOCATE      43²43'24.6"N 070²00'20.0"W
            COLOUR      green
            BOYSHP      can (cylindrical)
            COLPAT      horizontal stripes
```

The ECU MODIFY Action

The MODIFY action is used to change 1 or more attributes of an object. The MODIFY action is structured as follows:

```
MODIFY
<tab> Object Acronym
<tab> <tab> OBJNAM                    <tab> Name of object
<tab> <tab> LOCATE                    <tab> latitude, longitude
<tab> <tab> Attribute Acronym         <tab> Attribute Value
<tab> <tab> Attribute Acronym         <tab> Attribute Value
                        ...
<tab> Object Acronym
<tab> <tab> Attribute Acronym         <tab> Changed Value
```

Note that ONLY those attributes that have changed are listed in the second part of the MODIFY action. For example, say the color of the above buoy is changed from "green" to "red", the following example applies:

```
MODIFY
      BOY   SPP
            OBJNAM      Mackerel Cove Buoy 1
            LOCATE      43²43'24.6"N 070²00'20.0"W
            COLOUR      green
            BOYSHP      can (cylindrical)
            COLPAT      horizontal stripes
      BOYSPP
            COLOUR      red
```

All known attributes are listed in the first part of the MODIFY action, so that it is easier for the ECDIS to identify the object being modified, in case of any ambiguity.

The ECU RLOCAT Action

The RLOCAT action is used to change the position of an object. The RLOCAT action is structured as

follows:

```
RLOCAT
<tab> Object Acronym
<tab> <tab> OBJNAM                    <tab> Name of object
<tab> <tab> LOCATE                    <tab> latitude, longitude
<tab> <tab> Attribute Acronym         <tab> Attribute Value
<tab> <tab> Attribute Acronym         <tab> Attribute Value
                        ...
<tab> Object Acronym
<tab> <tab> LOCATE                    <tab> Changed Value
```

Note that the only attribute allowed in the second section of the action is the LOCATE attribute. For example, if the example buoy is being moved from 43²43'24.6"N 070²00'20.0"W to 43²43'25.1"N 070²00'21.8"W, the following example applies:

```
RLOCAT
      BOY    SPP
             OBJNAM      Mackerel Cove Buoy 1
             LOCATE      43²43'24.6"N 070²00'20.0"W
             COLOUR      green
             BOYSHP      can (cylindrical)
             COLPAT      horizontal stripes
      BOYSPP
             LOCATE      43²43'25.1"N 070²00'21.8"W
```

APPENDIX J - ENC UPDATING FIELD TRIAL INSRUMENTS (October 1996)

INSTRUCTIONS For Using Prototype Display System

This tool was primarily developed to evaluate the requirements for manually updating an electronic navigational chart (ENC). You will be asked to perform 6 manual updates and answer questions concerning the format and display of these updates. A paper copy of the Electronic Chart Update (ECU) will be provided.

Survey questions have been embedded into the test. They will appear at various times throughout the test. They are not referenced in this instruction handout. But, please answer questions to the best of your knowledge. Take all the time you need, your answers are very important to this study on electronic chart updating.

A pre-questionnaire on your personal history and general electronic chart updating issues will be first.

Note - Always click "OK" do not use the "Enter" key - In particular, in *the Location Editor* dialog box. If "Enter " is used accidentally, crash program or perform an **"Undo"**

In application menu : select "Start" "Prk" "File" "Load app." "Pomo32", "Ecdis", Ecdis.dll".

When program starts, please answer questions as thoroughly as possible.

After last pre-questionnaire question, select "Dtrt_Rvr.000" to load ENC to be used for test. Left Click "OK" and log in.

TRAINING RUN

MODES

To change modes:

ACTION	RESULT
Select **Chart**	
Select **ObjectSelector** from the menu	*PopupDialog* dialog box appears
Select **Base Display** Select **All** Select **Base Display** and add individual groups of objects	Note how items can be selected and de-selected for viewing.
Left Click "Cancel"	Display seen during route monitoring (i.e. standard display)
Go through **Menu** including **Global Data**	

INSERT

To add an object:

ACTION	RESULT
Select **Manual Update**	
Select **Insert/Add** from the menu	*Password Box appears*
Enter Password, and Source of Update such as ECU# Left Click "OK"	*Manual Add* dialog box appears
Enter six character code of object to be added type "BOYSPP" - Buoy Special Purpose and Left Click "Search" For each attribute, select a value Left Click "View" if desired. Left Click "OK"	*Manual Add Verification* dialog box appears with your name and source of update filled in
Left Click on "Edit Position"	*Location Editor* dialog box appears
Left Click "Cancel"	*Manual Add Verification* dialog box appears
Add the necessary characteristics of the object by Left Clicking "Additional Characteristics" (which allows additions and modifications to related objects such as lights, fog signals, etc.)	*Attribute Editor* dialog box appears
Left Click "Add"	*Add Related Objects* dialog box appears
Select "Top marks/lights/fog signals" Left Click "Cancel"	*Attribute Editor* dialog box appears
Select "Buoy, Special Purpose"	Note "Attribute/Characteristics" list
Find and Select "Object Name" from list	*Select/Enter Value* box and *Apply* button appear
Enter any name and Left Click "Apply"	
Find and Select "Buoy Shape" from list	A list of possible shapes appear with the previously selected choice highlighted under *Select/Enter Value* box
Left Click "Cancel"	Manual Add Verification
Left Click "Cancel"	This ends manual add training

APPLICATION AND VERIFICATION

The *FIRST UPDATE* is a **DELETE**. Please use **ECU1.txt - Format 1**.

To delete an object:

ACTION	RESULT
Select **Manual Update**	
Select **Delete** from the menu	*Manual Delete* dialog box appears
Choice 1 -To input a position Left Click "OK"	*Location Finder* dialog box appears
Enter position and Left Click "OK"	*Manual Delete Verification* dialog box appears
Choice 2 - If object to delete is known - right click on object	*Manual Delete Verification* dialog box appears
Fill in remaining information in the *Manual Delete Verification* dialog box and Left Click "OK"	Please note: All manual updates performed will be viewed together

Please pay close attention to the format of the ECU.

The *SECOND UPDATE* is a **RELOCATE**. Please use **ECU2.txt - Format 2**.

To move an object:

ACTION	RESULT
Select **Manual Update**	
Select **Modify/Relocate** from the menu	*Manual Modify* dialog box appears
Choice 1 -To input a position Left Click "OK"	*Location Finder* dialog box appears
Enter position and Left Click "OK" Enter objects original location	*Manual Modify Verification* dialog box appears
Choice 2 - If object to delete is known - right click on object	*Manual Modify Verification* dialog box appears
Left Click on "Edit Position"	*Location Editor* dialog box appears
Enter new (i.e. move to) location Left Click "OK"	Manual Modify Verification
Fill in remaining information in the *Manual Modify Verification* dialog box and Left Click "OK"	

Note the change in the method of verifying your input , the format, and method for inputting location.

The *THIRD UPDATE* is an **INSERT**. Please use **ECU3.txt - Format 3**
To add an object:

ACTION	RESULT
Select **Manual Update**	
Select **Insert/Add** from the menu	*Manual Add* dialog box appears
Choice 1 - select a type, select an object, for each attribute, select a value for object to be added - Left Click on "View" if desired. Left Click "OK"	*Manual Add Verification* dialog box appears
Choice 2 - enter six character code of object to be added and Left Click "search" then for each attribute, select a value - Left Click on "View" if desired. Left Click "OK"	*Manual Add Verification* dialog box appears
Left Click on "Edit Position"	*Location Editor* dialog box appears
Enter position of object to be added, Left Click "OK"	*Manual Add Verification* dialog box appears
Add the necessary characteristics of the object by Left Clicking "Additional Characteristics" (which allows additions and modifications to related objects such as lights, fog signals, etc.)	*Attribute Editor* dialog box appears
Add Attributes/Characteristics as necessary to complete manual update, don't forget to "Apply" values when necessary Left Click "OK" when done.	*Manual Add* dialog box appears
Fill in remaining information in the *Manual Add Verification* dialog box and Left Click "OK"	

Note the change in the format and method for inputting the objects (i.e. buoys, lights) characteristics.

The *FORTH UPDATE* is a **MODIFY**. Please use **ECU4.txt - Format 4**

To modify an object:

ACTION	RESULT
Select **Manual Update**	
Select **Modify/Relocate** from the menu	*Manual Modify* dialog box appears
Choice 1 -To input a position Left Click "OK"	*Location Finder* dialog box appears
Enter position and Left Click "OK"	*Manual Modify Verification* dialog box appears
Choice 2 - If object to delete is known - right click on object	*Manual Modify Verification* dialog box appears
Left Click "Modify Characteristics"	*Attribute Editor* dialog box appears
Select "Add"	*Add Related Objects* dialog box appears
Select type etc. Don't forget to apply. Left Click "OK"	*Attribute Editor* dialog box appears
Fill in remaining information available in ECU. Left Click "OK"	*Manual Modify Verification* dialog box appears
Fill in remaining information in the *Manual Modify Verification* dialog box and Left Click "OK"	*Manual Update Final Verification* dialog box appears
Left Click "Accept" or "Reject"	All four updates are now visible. Please spend some time reviewing them.

Note the change in the general format of the ECU.

To change to Route Monitoring Mode and exit program:

ACTION	RESULT
Select **Chart**	
Select **ObjectSelector** from the menu	*PopupDialog* dialog box appears
Select **Standard Display**	All, standard display items are highlighted
Left Click "OK"	Display seen during route monitoring
Select **File** Select **Exit**	*Saving SENC* dialog box appears showing a list of updates
Left Click "OK"	

COLORS & SYMBOLS DURING ROUTE MONITORING

Now you will view the updates you have applied by changing to the route monitoring mode (Standard Display). Up until now you have been in the Manual Updating mode.

In application menu : select "Start" "Prk" "File" "Load app." "Pomo32", "Ecdis", Ecdis.dll". When program starts, Log in again - same as before.

Select **Scale, Zoom out, 2X** from the menu, then Left Click cursor on area above buoys 3 and 4

When the program is reloaded, note the display of the modified object. Scroll as necessary to view. Ask questions and discuss.

ACTION	RESULT
Method 1 - if orange	
Select **Manual Update**	
Select **OtherView** from the menu	Chart is redrawn with alternate method of displaying manually updated objects. Take some time to discuss differences. Feel free to ask questions.
Right Click on an object that has not been updated. Right Click on an updated object.	Note the difference in information in the *Info* dialog box for updated and non updated objects.
Method 2 - if no orange	
Right Click on an object that has not been updated. Right Click on an updated object.	Note the difference in information in the *Info* dialog box for updated and not updated objects.
Select **Manual Update**	
Select **OtherView** from the menu	Chart is redrawn with alternate method of displaying manually updated objects. Take some time to discuss differences. Feel free to ask questions.
Select **File** Select **Exit**	*Saving SENC* dialog box appears showing a list of updates

Left Click "OK" View Log at this point. (See instructions below)	

LOGGING

In order to View the Log - From Operating System Window perform the following:

Left Click "Control Panel" Left Click "File Manager", locate log.txt file, Double click on Log.txt file Press "Alt Shift >" at once to take you to bottom of file for review	*Displays Log File*
Review and discuss log file. Take some time to study the contents of the log	
From menu select Files then select Exit	

In application menu : select "Start" "Prk" "File" "Load app." "Pomo32", "Ecdis", Ecdis.dll". When program starts, Log in again - same as before.

HIGHLIGHTING

Now you will examine highlighting. First you will be shown how manually updated feature can be highlighted. Afterwards, you will see how they might always appear on the chart.

ACTION	RESULT
Method 1 - orange	
Select **Manual Update** Select **Other View**	Chart redraws with alternate method of displaying the manual updates.
Select **Manual Update** Select **Highlight** Select **All Manual Updates** from the menu	Chart redraws with added updates circled in orange and deleted objects with an orange slash.
Method 2 - no orange	

Select **Manual Update** Select **Highlight** Select **All Manual Updates** from the menu	Chart redraws with added updates circled in orange and deleted objects with an orange slash.
Select **Manual Update** Select **Other View**	Chart redraws with alternate method of displaying the manual updates.

REMOVE (UNDO) MANUAL UPDATES

Select **Manual Update** Select **Undo** from the menu	*Manual Update Undo* dialog box appears
Select "Buoy Lateral" (West Out CHLB02) to Undo Left Click "OK"	Note display
Right Click to see "Info" dialog box	
Select **File** Select **Exit**	*Saving SENC* dialog box appears showing a list of updates
Left Click "OK"	

MANUAL UPDATING OF LINES

In application menu : select "Start" "Prk" "File" "Load app." "Pomo32", "Ecdis", Ecdis.dll". When program starts, Log in again - same as before.

Select **Manual Update**	
Select **Modify/Relocate** from the menu	*Password Box appears*
Enter Password, and ECU # (Source of Update)Left Click "OK"	*Manual Modify* dialog box appears
Find location of one point of line with cursor and Lat/Lon dialog box Right Click on object	*Manual Modify Verification* dialog box appears
Modify Characteristics	*Attribute Editor* dialog box appears
Edit necessary data - Don't forget to Left Click "Apply" when entering values Left Click "OK" when done	*Manual Modify Verification* dialog box appears

Left Click "OK"	Line update will be viewed after area update is complete.

MANUAL UPDATING OF AREAS

Select **Manual Update**	
Select **Modify/Relocate** from the menu	*Manual Modify* dialog box appears
Find location of one point of area Right Click on object or Right Click on - i box -	*Manual Modify Verification* dialog box appears
Modify Characteristics	*Attribute Editor* dialog box appears
Edit necessary data - Don't forget to apply Left Click "OK" when done	*Manual Modify Verification* dialog box appears
Left Click "OK"	Appearance of area border and pattern fill, as well as line update, will change

To change to Route Monitoring mode and exit program:

Select **Chart** Select **Object selector** Select **Standard display**	
Select **File** Select **Exit** Click "Bring up exit questions" Answer questions Click "No"	*Saving SENC* dialog box appears showing a list of updates

The final part of the test is an exit survey. Please take your time to answer and comment on the remaining question.

The Integrated Navigation Project Team would like to thank you for all your time and effort. Your participation in this field trial test, is extremely important to further the development of international standards on electronic chart updating.

Thank you again.
Irene M. Gonin
United States Coast Guard

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DEFINITIONS/ACRONYMS

1. **ECDIS** - Electronic Chart Display and Information System

2. **ENC** - Electronic Navigational Chart - this is the chart data in digital form.

3. **SENC** - System Electronic Navigational Chart - this is the processed chart information displayed on the screen. When information is incorporated into the SENC, this means that the information is integrated with all the other information displayed.

4. **OVERLAY** - A layer of information which lays on top of the SENC, which displays graphical information. This information layer is not integrated/connected to the information contained in the SENC.

5. **OBJECT** - An item which relates to real world things. These objects can be points (e.g. buoys, lights, soundings), lines (e.g. cables, contour), or areas (e.g. no fishing, anchorage, channels).

6. **ATTRIBUTES** define objects. For example: a buoy has a color and a shape. It may have another object attached to it, for instance a light. The light would then have it's own attributes such as, color, signal period, intensity, etc.

7. **ECU** - Electronic Chart Update. This is the equivalent in content to Section IV of a local notice to mariner (LNM) called chart corrections. The format is quite different.

8. **S57 FORMAT** - A format used to describe hydrographic data digitally. This format is sometimes referred to as computer readable data.

9. **TEXT TRANSLATION** - Translation of S57 - computer readable information to human readable information.

10. **GLOBAL DATA**:

    - **SAFETY_DEPTH in meters**
      - The depth of water the mariner feels is safe for their vessel's given draft.
      - This value will effect the color of soundings in depth areas

    - **SHALLOW_CONTOUR in meters**
      - The color and pattern shown of unsafe water (any depth more shallow then the specified safety depth area)

    - **SAFETY_CONTOUR in meters**
      - The contour defined between safe and unsafe will be displayed with a thick line

- Depth area colors will be different between safe and unsafe water
- Isolated dangers will be displayed if depth of danger is an unsafe value

- **DEEP_CONTOUR in meters**
  - Deep water can be displayed in a different color from safe and unsafe depth areas. Gives display three colors for depth contours.

- **TWO_SHADES**
  - Flag (TRUE/FALSE) indicating selection of two depth shades (on/off)
  - If this value is set to TRUE, then only two depth area colors will be displayed. If set to FALSE, then three depth area colors will be displayed.

- **SHALLOW_PATTERN**
  - Flag (TRUE/FALSE) indicating selection of shallow water highlight (on/off)
  - If this value is set to TRUE, then a special pattern will be displayed in shallow water specified by shallow water value. If set to FALSE, no pattern will be displayed.

11. **MANUAL UPDATING** - the process, performed by the mariner, of physically applying (i.e. through the use of computer tools) chart corrections to the electronic chart. This process uses ECU's - Electronic Chart Updates.

12. **AUTOMATIC UPDATING** - the process, performed by the ECDIS, of automatically applying chart corrections to the electronic chart. This process uses official updates.

Questionnaire for 1996 Field Trial Test on ENC Updating

1
What type of vessel do you regularly sail? (1)
A) General Cargo
B) Bulb/Ore Carrier
C) Oil Tanker
D) Passenger Vehicle/Ferry
E) Container Vessel
F) Ice Breaker
G) Buoy Tender
H) Scientific
I) Other (please specify)

2
What is the size range of the vessel you sail? (2)
A) small (0 - 75m)
B) medium (75 - 150m)
C) large (150m -)

3
What level of familiarity do you have with computers? (3)
A) none
B) novice
C) intermediate
D) experienced
E) expert

4
How much experience do you have with any electronic chart system? (4)
A) 1 - 2 years
B) 2 - 4 years
C) more than 4 years

5
The primary benefit of correcting and updating charts paper is to (5)
ensure that the best and most accurate information is available
to the vessel for navigation. Do you believe that there are other
benefits gained while performing this task (feel free to comment)?
A) Yes
B) No

6
Total number of years you have sailed as a licensed mariner: (6)
A) more than 20
B) 15-20 years
C) 10-15 years
D) 5-10 years
E) less than 5 years
7

What position do you normally occupy aboard the vessel? (7)
A) Master
B) Chief
C) 1st Officer
D) 2nd Officer
E) 3rd Officer
F) Quarter Master
G) Bridge Officer

8
What is the highest position you have occupied aboard any vessel? (8)
A) Master
B) Chief
C) 1st Officer
D) 2nd Officer
E) 3rd Officer
F) Quarter Master
G) Bridge Officer

9
What type of vessels have you sailed? (9)
(YOU MAY CIRCLE MORE THAN ONE)
A) General Cargo
B) Bulb/Ore Carrier
C) Oil Tanker
D) Passenger Vehicle/Ferry
E) Container Vessel
F) Ice Breaker
G) Buoy Tender
H) Scientific
I) Other (please specify)

10
What is your age group? (10)
A) 60+
B) 50-59
C) 40-49
D) 30-39
E) 20-29

High (H), medium (M) and low(L) ratings for the following questions are to determine the overall importance of that feature or function to updating an electronic chart.

Questions with two numbers indicate that the same question is asked again, after the mariner has an opportunity to perform a task relating to updating the chart on the field trial display tool.

11 30
I feel comfortable making changes (applying updates directly) (11)
to the System Electronic Navigation Chart (SENC).
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

12
The standard states that "..Manual Updates should be distinguishable (21)
from the ENC information and its Official Updates, but not affect
display legibility.." Which of the following best meets these
requirements:
A) the object is displayed in standard colors and symbols, and can
be highlighted on demand.
B) the object is at all times displayed in the color orange.
C) other H M L

13 41
The standard states that "..Manual Updates should be distinguishable (26)
from the ENC information and its Official Updates..." This has usually
been interpreted to mean that the updated objects should remain Orange
at all times. I would consider these requirements to be sufficiently met
with the ability to highlight Manual Updates on demand.
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

14 25
Which of the following methods of highlighting would be most (27)
effective to distinguish Manual Update information from the ENC
and its Official Updates.
A) manually updated objects are displayed in orange at all times.
B) all updates are circled or slashed in orange only upon request.
C) information about the object is available by double-clicking on
the object
D) choices b and c together.
E) other H M L

15 45
Manual Updates for lines and areas objects will sometimes result in (34)
large changes to the SENC. I am comfortable with this level of
Mariner-controllable change of the SENC.
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

16 46
When an Official (i.e., Automatic) Update is received for objects which have already been updated manually, how should those Manual Updates be cleared from the ECDIS to prepare for the application of the Official Update: (35)
A) Manual Updates should be cleared by the mariner.
B) Official Updates should automatically replace Manual Updates, requiring no clearing from the mariner.
C) Other

H M L

17 33
With which Lat-Long format are you most comfortable: (14)
A) degree minutes and decimal minutes.
B) degrees and decimal degrees.
C) other

H M L

18 34
Lat-long formats in the ECU may be in degrees and decimal degrees. I find this to be: (15)
A) Highly Objectionable
B) Objectionable
C) Acceptable
D) Highly Acceptable

H M L

19 37
In Manual Updating, the mariner should be provided which of the following methods to verify the information in the electronic chart update (ECU). (18)
A) a textual window containing entered update information.
B) a graphical check depicting update on chart.
C) a textual window as well as a graphical check.
D) Other

H M L

20
Which of the following methods of displaying inserted objects best meets these requirements for Manual Updates stated above: (22)
A) the object is displayed in standard colors and symbols, and can be highlighted on demand.
B) the object is at all times displayed in the color orange.

H M L

21
Which of the following methods of displaying deleted objects best meets these requirements for Manual Updates stated above: (23)
A) the object is removed from display, but would show up when highlighted on demand.
B) the object is displayed in the original color with orange slash over symbol.

H M L

22
Which of the following methods of displaying modified objects best (24)
meets these requirements for Manual Updates stated above:
A) the original object is removed from display, the modified object
is displayed in standard colors and symbols and both can be
highlighted on demand (i.e, orange circle to highlight new
object and orange slash to highlight old object).
B) the original object is displayed with an orange slash through it,
and modified objects are displayed in orange, offset by a user
specified distance. H M L

23
Which of the following methods of displaying relocated objects best (25)
meets these requirements for Manual Updates stated above:
A) the original object is no longer displayed, the moved object
is displayed in standard colors and symbols at the new location,
and both can be highlighted on demand (i.e, orange circle to
highlight new object and orange slash to highlight old object).
B) the original object is displayed with an orange slash through it,
and moved objects are displayed at the new location in orange. H M
L

24 43
Which of the following data should be entered into the ENC Update Log? (30)
(YOU MAY CIRCLE MORE THAN ONE)
A) time and date
B) S-57 Object ID and object name
C) location (lat-long)
D) source of update information (i.e., LNM)
E) mariner's name
F) type of application (manual or automatic)
G) ability to log any anomalies encountered during application
H) edition number of ENC
I) Other H M L

25 14
Which of the following methods of highlighting would be most (27)
effective to distinguish Manual Update information from the ENC
and its Official Updates.
A) manually updated objects are displayed in orange at all times.
B) the object is circled or slashed in orange only upon request.
C) information about the object is available by double-clicking on
the object
D) choices b and c together. H M L

26 42
Textual information should always accompany the highlight display. (28)
A) Strongly Disagree
B) Disagree

C) Agree
D) Strongly agree H M L

27
The ability to retrieve update as well as general information by clicking on manually updated objects sufficiently meets the requirement to distinguish Manual Update information from the ENC and its Official Updates. (29)
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

28
I found the implementation for Manual Updates of Lines I used today to be straightforward. (32)
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

29
I found the implementation for Manual Updates of Areas I used today to be straightforward. (33)
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

30 11
I feel comfortable making changes (applying updates directly) to the System Electronic Navigation Chart (SENC). (11)
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

31
Currently there are two procedures by which Manual Updates are applied to the SENC: Overlay- in which the Manual Update is applied only graphically (i.e., there are no connections to the underlying attribute information); Incorporated - in which the Manual Update is applied directly to the SENC and allows connection to the underlying attribute information. I feel that manual updates should be an overlay, and should not be directly applied to the SENC. (12)
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

32
What information should be included in the (13)
Electronic Chart Update (ECU):
A) only supply mandatory attributes
(i.e., those specified by the standard as necessary).
B) supply mandatory attributes as well any other
information available.
C) Other H M L

33 17
With which Lat-Long format are you most comfortable: (14)
A) degree minutes and decimal minutes.
B) degrees and decimal degrees. H M L

34 18
Lat-long formats in the ECU may be in degrees and decimal degrees. (15)
I find this to be:
A) Highly Objectionable
B) Objectionable
C) Acceptable
D) Highly Acceptable H M L

35 16
The manual ECU should contain which of the following: (16)
A) only the text equivalent of the computer readable data
B) both the computer readable data as well as its text equivalent H M L

36 17
The manual ECU will most likely have both the computer readable data (17)
as well as its text equivalent. I find this to be:
A) Highly Objectionable
B) Objectionable
C) Acceptable
D) Highly Acceptable H M L

37 19
In Manual Updating, the mariner should be provided which of the (18)
following methods to verify the information in the electronic
chart update (ECU).
A) a textual window containing entered update information.
B) a graphical check depicting update on chart.
C) a textual window as well as a graphical check.
D) Other H M L

38
The mariner should be provided the facility to enter the rejected (19)
object(s) in a log stating why the object was unacceptable.
A) Strongly Disagree

B) Disagree
C) Agree
D) Strongly agree H M L

39
I would like a screen to allow the logging of a remark as to why I (20)
have rejected the Manual Update?
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

40
The standard states that "..Manual Updates should be distinguishable (21)
from the ENC information and its Official Updates, but not affect
display legibility.." Which of the following best meets these
requirements:
A) the object is displayed in standard colors and symbols, and can
be highlighted on demand.
B) the object is at all times displayed in the color orange. H M L

41 13
The standard states that "..Manual Updates should be distinguishable (26)
from the ENC information and its Official Updates..." This has usually
been interpreted to mean that the updated objects should remain Orange
at all times. I would consider these requirements to be sufficiently met
with the ability to highlight Manual Updates on demand.
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

42 26
Textual information should always accompany the highlight display. (28)
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

43 24
Which of the following data should be entered into the ENC Update Log? (30)
(YOU MAY CIRCLE MORE THAN ONE)
A) time and date
B) S-57 Object ID and object name
C) location (lat-long)
D) source of update information (i.e., LNM)
E) mariner's name
F) type of application (manual or automatic)
G) ability to log any anomalies encountered during application

H) edition number of ENC
I) Other H M L

44
It should only be possible for a mariner to get in (or out) of (31)
"updating mode" by typing in a user id and password.
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

45 15
Manual Updates for lines and areas objects will sometimes result in (34)
large changes to the SENC. I am comfortable with this level of
Mariner-controllable change of the SENC.
A) Strongly Disagree
B) Disagree
C) Agree
D) Strongly agree H M L

46 16
When an Official (i.e., Automatic) Update is received for objects (35)
which have already been updated manually, how should those Manual
Updates be cleared from the ECDIS to prepare for the application
of the Official Update:
A) Manual Updates should be cleared by the mariner.
B) Official Updates should automatically replace Manual Updates,
requiring no clearing from the mariner.
C) Other H M L

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Interactive Directions/Comments Imbedded in the Prototype Display System

Before starting first mariner in Canada:

1) Copy: survey\S_5.txt to ecdis\survey.txt
2) Open log.txt in Notepad (i.e. double click) and delete entries after 9/26/96 (Control Shift End).

After each mariner:

Using File Manager back up survey.txt. In directory survey, copy survey.txt to ..\survey\s_{mariner test #}.txt

Before each new mariner:

Using File Manager copy test2\ecdis.ob to ..\ecdis

When viewing log with mariner go to end of document by using Control End.

Areas: Move verification box, highlight second position, click edit position , Control C.

1 Welcome to the USCG R&D Center's Chart Update Evaluation Tool.
To test the requirements of manual updating you will be asked to perform 6 manual updates and answer questions concerning the format and display of these updates. First take a few minutes to respond to some preliminary questions.

21 The next set of questions will involve questions about your preference for the display and functionality of manual updating in an ECDIS environment. Associated with each question is a rating of the subject matter of that question to the overall importance to ECDIS. For example, you may have a strong preference for some option we present, but don't feel your personal preference should dictate the overall direction of ECDIS development.

2 Thank you for taking the time to answer the preliminary questions.
Next, the ENC is loaded and then you will be led through an instructive scenario to familiarize you with the manual update mechanism we have chosen for this tool.

3 This ends the training scenario.
You now will apply four manual updates to the chart, a deletion, a relocation, an insertion, and a modification. Although each will be applied to the chart, the display will not reflect these changes until all four are complete.
Update number 1, DELETE:
Note: method of verifying your input, and format and method for inputting location.

4 The deletion is complete.
Applying Update number 2, RLOCAT (move):
Note: format and method for inputting location.

5 The relocation is complete.
Applying Update number 3, INSERT:
Note: the difference in applying required and optional buoy characteristics.

6 The insertion is complete.
Applying Update number 4, MODIFY:
Note: The change in the methods of verifying your input (the chart will be redrawn prior to final acceptance) and ECU provides only the textual description of the updates.

7 All four manual modification are complete.
Time for a coffee break!
Please switch to standard display, exit and save your updates.

8 View manual updates:
To View all applied updates simultaneously,
Zoom out 2X, centering along channel just above buoys 3 & 4.
Carefully Note: Display of the manual updates you applied.

28 View manual updates:
Toggle to other view:
Note: the change in how the updates are displayed.

9 View manual updates:
Carefully Note: Difference in the way manual updates are displayed.

10 Odd (no questions) Now we will examine highlighting.
First you will see how they could appear if ALWAYS displayed on the chart.
Afterwards, you will be shown how manually updated features can be highlighted.

11 Even (questions) Now we will examine highlighting.
First you will be shown how manually updated features can be highlighted.
Afterwards, you will see how they could appear if ALWAYS displayed on the chart.

12 Please exit, save, and examine the update log (log.txt).
Note: The contents of the log.

13 Applying Update number 5, LINES:
Note: method for entering update.

23 The update has been returned to it's original state. Questions concerning this operation will follow the final exercise.
Exit and save, then restart and continue with update # 5.

14 Applying Update number 6, AREAS:
Note: method for entering update.

15 Zoom In 2x,
Exit and save, then restart and continue with update # 5.

25 Clearing out manual updates:
Note: the process for Undoing updates and what can be rectified in the SENC.

16 You have completed the interactive part of this survey.
As you exit, please take a few more minutes to complete the wrap-up questions.

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ELECTRONIC CHART UPDATE

Cell Number: DTRT_RVR
Update Number: 001
LNM Date: 19960913
Source: USCG R&DC

Comments: This is a prototype ECU and is still undergoing development at the USCG R&DC.
This prototype contains:
Latitude & Longitude format I: Degrees & Decimal degrees
Attribute format I: S57 required ONLY
Notation method I: S57 Abbreviations & Text translations
S57 Abbreviations for Objects & Attributes can be found in the "IHO Transfer Standard for Digital Hydrographic Data, Version 2.0, Special Publication No. 57, Appendix A"

The are 4 types of chart corrections output: INSERT, DELETE, RLOCAT and MODIFY. The basic format for an ECU Chart Corrections is as follows:

```
ECU Action
<tab>   Object Acronym
<tab>   <tab>   Attribute Acronym       <tab>   Attribute Value
                ...
<tab>   <tab>   Attribute Acronym       <tab>   Attribute Value
```

An asterisk "*" in a MODIFY attribute field indicates the characteristic of the object that is changing. A blank attribute value represents unknown information.

Notice/Disclaimer: All users of this Electronic Chart Update (ECU) are hereby put on notice that use of this program to produce certain desired results is entirely at the risk of the user. The Government makes no representations regarding the reliability or accurateness of the ECU and specifically warns all users that the ECU is not intended for use in ANY navigational program. Further, the Government does not make any warranties, express or implied, concerning the reliability or accurateness of the data contained in the ECU; assumes no liability for the correctness of the results produced through the use of this ECU; and assumes no liability for damages, which may occur through use of this ECU

```
            S57 Format Update                          |       Text Translation
-------------------------------------------------------------------------------------------
DELETE
        RDOCAL                                          ; Radio calling-in point
                OBJNAM  12                              ; Object name
                LOCATE  42.009144°N, 83.122388°W        ; Location     42° 0'32.918"N, 83° 7'20.597"W
                ORIENT  337.00                          ; Orientation
                TRAFIC  one-way                         ; Traffic flow

RLOCAT
        BOYLAT                                          ; Buoy, lateral
                OBJNAM  WEST OUTER CH B 09              ; Object name
                OLDLOC  42.001123°N, 83.144821°W        ; Old location 42° 0' 4.043"N, 83° 8'41.256"W
                NEWLOC  41.997504°N, 83.145806°W        ; New location 41°59'51.014"N, 83° 8'44.902"W
                BOYSHP  can (cylindrical)               ; Buoy shape
                CATLAM  port-hand lateral mark          ; Category of lateral mark
                COLMAR  green                           ; Colour of navigational mark

INSERT
        BOYLAT                                          ; Buoy, lateral
                OBJNAM  WEST OUT CH B 10                ; Object name
                LOCATE  41.997504°N, 83.142646°W        ; Location     41°59'51.014"N, 83° 8'33.526"W
                BOYSHP  conical (nun, ogival)           ; Buoy shape
                CATLAM  starboard-hand lateral mark     ; Category of lateral mark
                COLMAR  red                             ; Colour of navigational mark

MODIFY
        BOYLAT                                          ; Buoy, lateral
                OBJNAM  WEST OUT CH B 02                ; Object name
                LOCATE  41.950728°N, 83.155596°W        ; Location     41°57' 2.621"N, 83° 9'21.456"W
                CATLAM  starboard-hand lateral mark     ; Category of lateral mark
                BOYSHP  conical (nun, ogival)           ; Buoy shape
                COLMAR  red                             ; Colour of navigational mark
        BOYLAT                                          ; Buoy, lateral
        *       OBJNAM  WEST OUT CH LB 02               ; Object name
                LOCATE  41.950728°N, 83.155596°W        ; Location     41°57' 2.621"N, 83° 9'21.456"W
                CATLAM  starboard-hand lateral mark     ; Category of lateral mark
```

```
            BOYSHP  conical (nun, ogival)          ; Buoy shape
            COLMAR  red                            ; Colour of navigational mark
        *   LIGHTS                                 ; Light
                    OBJNAM  WEST OUT CH LB 02      ; Object name
                    COLOUR  red                    ; Colour
                    LITCHR  flashing               ; Light characteristic
                    SIGPER  6.0                    ; Signal period
                    SIGGRP  ()                     ; Signal group

MODIFY
        DEPCNT                                     ; Depth contour
            OBJNAM  FE___05399                     ; Object name
            LOCATE  42.004310°N, 83.149306°W       ; Location     42° 0'15.516"N, 83° 8'57.502"N
                    42.003704°N, 83.149306°W
                    42.003089°N, 83.149293°W
                    42.002772°N, 83.149280°W
                    42.001792°N, 83.149138°W
                    42.000581°N, 83.148597°W
                    41.999850°N, 83.148082°W
                    41.999245°N, 83.147927°W
                    41.998630°N, 83.147773°W
                    41.997476°N, 83.147463°W
                    41.996813°N, 83.147618°W
                    41.996207°N, 83.147863°W
                    41.995592°N, 83.148120°W
                    41.995073°N, 83.148327°W
                    41.994477°N, 83.148417°W
                    41.993871°N, 83.148391°W
                    41.993256°N, 83.148365°W
                    41.992305°N, 83.148314°W
                    41.991853°N, 83.148391°W
                    41.991334°N, 83.148700°W
                    41.990536°N, 83.148713°W
                    41.990286°N, 83.148816°W
                    41.989767°N, 83.149306°W
                    41.989094°N, 83.150169°W
                    41.988671°N, 83.150981°W
                    41.988238°N, 83.151806°W
                    41.988152°N, 83.151986°W
            VALDCO  5.00                           ; Value of depth contour
        DEPCNT                                     ; Depth contour
            OBJNAM  FE___05399                     ; Object name
            LOCATE  42.004310°N, 83.149306°W       ; Location     42° 0'15.516"N, 83° 8'57.502"N
                    42.003704°N, 83.149306°W
                    42.003089°N, 83.149293°W
                    42.002772°N, 83.149280°W
                    42.001792°N, 83.149138°W
                    42.000581°N, 83.148597°W
                    41.999850°N, 83.148082°W
                    41.999245°N, 83.147927°W
                    41.998630°N, 83.147773°W
                    41.997476°N, 83.147463°W
                    41.996813°N, 83.147618°W
                    41.996207°N, 83.147863°W
                    41.995592°N, 83.148120°W
                    41.995073°N, 83.148327°W
                    41.994477°N, 83.148417°W
                    41.993871°N, 83.148391°W
                    41.993256°N, 83.148365°W
                    41.992305°N, 83.148314°W
                    41.991853°N, 83.148391°W
                    41.991334°N, 83.148700°W
                    41.990536°N, 83.148713°W
                    41.990286°N, 83.148816°W
                    41.989767°N, 83.149306°W
                    41.989094°N, 83.150169°W
                    41.988671°N, 83.150981°W
                    41.988238°N, 83.151806°W
                    41.988152°N, 83.151986°W
        *   VALDCO  2.00                           ; Value of depth contour

RLOCAT
        DMPGRD                                     ; Dumping ground
            OBJNAM  FE___00250                     ; Object name
            OLDLOC  41.957862°N, 83.145994°W       ; Old location 41°57'28.303"N, 83° 8'45.578"N
                    41.960671°N, 83.132503°W
                    41.923276°N, 83.117826°W
                    41.909321°N, 83.157991°W
                    41.957862°N, 83.145994°W
```

```
NEWLOC  41.960671°N, 83.145994°W        ; New location 41°57'38.416"N, 83° 8'45.578"N
        41.960671°N, 83.132503°W
        41.923276°N, 83.117826°W
        41.909321°N, 83.157991°W
        41.960671°N, 83.145994°W
CATDPG  general dumping ground          ; Category of dumping ground
STATUS  temporary                       ; Status
```

ELECTRONIC CHART UPDATE

Cell Number: DTRT_RVR
Update Number: 001
LNM Date: 19960913
Source: USCG R&DC

Comments: This is a prototype ECU and is still undergoing development at the USCG R&DC.
This prototype contains:
Latitude & Longitude format II: Degrees, minutes & decimal minutes
Attribute format I: S57 required ONLY
Notation method I: S57 Abbreviations & Text translations
S57 Abbreviations for Objects & Attributes can be found in the "IHO Transfer Standard for Digital Hydrographic Data, Version 2.0, Special Publication No. 57, Appendix A"

The are 4 types of chart corrections output: INSERT, DELETE, RLOCAT and MODIFY. The basic format for an ECU Chart Corrections is as follows:

ECU Action
<tab> Object Acronym
<tab> <tab> Attribute Acronym <tab> Attribute Value
...
<tab> <tab> Attribute Acronym <tab> Attribute Value

An asterisk "*" in a MODIFY attribute field indicates the characteristic of the object that is changing. A blank attribute value represents unknown information.

Notice/Disclaimer: All users of this Electronic Chart Update (ECU) are hereby put on notice that use of this program to produce certain desired results is entirely at the risk of the user. The Government makes no representations regarding the reliability or accurateness of the ECU and specifically warns all users that the ECU is not intended for use in ANY navigational program. Further, the Government does not make any warranties, express or implied, concerning the reliability or accurateness of the data contained in the ECU; assumes no liability for the correctness of the results produced through the use of this ECU; and assumes no liability for damages, which may occur through use of this ECU

S57 Format Update		Text Translation
DELETE		
RDOCAL		; Radio calling-in point
OBJNAM	12	; Object name
LOCATE	42° 0.54854'N, 83° 7.34328°W	; Location 42° 0'32.918"N, 83° 7'20.597"W
ORIENT	337.00	; Orientation
TRAFIC	one-way	; Traffic flow
RLOCAT		
BOYLAT		; Buoy, lateral
OBJNAM	WEST OUTER CH B 09	; Object name
OLDLOC	42° 0.06738'N, 83° 8.68926'W	; Old location 42° 0' 4.043"N, 83° 8'41.256"W
NEWLOC	41° 59.85024'N, 83° 8.74836'W	; New location 41°59'51.014"N, 83° 8'44.902"W
BOYSHP	can (cylindrical)	; Buoy shape
CATLAM	port-hand lateral mark	; Category of lateral mark
COLMAR	green	; Colour of navigational mark
INSERT		
BOYLAT		; Buoy, lateral
OBJNAM	WEST OUT CH B 10	; Object name
LOCATE	41° 59.85024'N, 83° 8.55876'W	; Location 41°59'51.014"N, 83° 8'33.526"W
BOYSHP	conical (nun, ogival)	; Buoy shape
CATLAM	starboard-hand lateral mark	; Category of lateral mark
COLMAR	red	; Colour of navigational mark
MODIFY		
BOYLAT		; Buoy, lateral
OBJNAM	WEST OUT CH B 02	; Object name
LOCATE	41° 57.04368'N, 83° 9.33576'W	; Location 41°57' 2.621"N, 83° 9'21.456"W
CATLAM	starboard-hand lateral mark	; Category of lateral mark
BOYSHP	conical (nun, ogival)	; Buoy shape
COLMAR	red	; Colour of navigational mark
BOYLAT		; Buoy, lateral
* OBJNAM	WEST OUT CH LB 02	; Object name
LOCATE	41° 57.04368'N, 83° 9.33576'W	; Location 41°57' 2.621"N, 83° 9'21.456"W
CATLAM	starboard-hand lateral mark	; Category of lateral mark

```
                BOYSHP  conical (nun, ogival)           ; Buoy shape
                COLMAR  red                             ; Colour of navigational mark
        *       LIGHTS                                  ; Light
                        OBJNAM  WEST OUT CH LB 02       ; Object name
                        COLOUR  red                     ; Colour
                        LITCHR  flashing                ; Light characteristic
                        SIGPER  6.0                     ; Signal period
                        SIGGRP  ()                      ; Signal group

MODIFY
        DEPCNT                                          ; Depth contour
                OBJNAM  FE___05399                      ; Object name
                LOCATE  42° 0.25860'N, 83° 8.95836'W    ; Location     42° 0'15.516"N, 83° 8'57.502"N
                        42° 0.22224'N, 83° 8.95836'W
                        42° 0.18534'N, 83° 8.95758'W
                        42° 0.16632'N, 83° 8.95680'W
                        42° 0.10752'N, 83° 8.94828'W
                        42° 0.03486'N, 83° 8.91582'W
                        41° 59.99100'N, 83° 8.88492'W
                        41° 59.95470'N, 83° 8.87562'W
                        41° 59.91780'N, 83° 8.86638'W
                        41° 59.84856'N, 83° 8.84778'W
                        41° 59.80878'N, 83° 8.85708'W
                        41° 59.77242'N, 83° 8.87178'W
                        41° 59.73552'N, 83° 8.88720'W
                        41° 59.70438'N, 83° 8.89962'W
                        41° 59.66862'N, 83° 8.90502'W
                        41° 59.63226'N, 83° 8.90346'W
                        41° 59.59536'N, 83° 8.90190'W
                        41° 59.53830'N, 83° 8.89884'W
                        41° 59.51118'N, 83° 8.90346'W
                        41° 59.48004'N, 83° 8.92200'W
                        41° 59.43216'N, 83° 8.92278'W
                        41° 59.41716'N, 83° 8.92896'W
                        41° 59.38602'N, 83° 8.95836'W
                        41° 59.34564'N, 83° 9.01014'W
                        41° 59.32026'N, 83° 9.05886'W
                        41° 59.29428'N, 83° 9.10836'W
                        41° 59.28912'N, 83° 9.11916'W
                VALDCO  5.00                            ; Value of depth contour
        DEPCNT                                          ; Depth contour
                OBJNAM  FE___05399                      ; Object name
                LOCATE  42° 0.25860'N, 83° 8.95836'W    ; Location     42° 0'15.516"N, 83° 8'57.502"N
                        42° 0.22224'N, 83° 8.95836'W
                        42° 0.18534'N, 83° 8.95758'W
                        42° 0.16632'N, 83° 8.95680'W
                        42° 0.10752'N, 83° 8.94828'W
                        42° 0.03486'N, 83° 8.91582'W
                        41° 59.99100'N, 83° 8.88492'W
                        41° 59.95470'N, 83° 8.87562'W
                        41° 59.91780'N, 83° 8.86638'W
                        41° 59.84856'N, 83° 8.84778'W
                        41° 59.80878'N, 83° 8.85708'W
                        41° 59.77242'N, 83° 8.87178'W
                        41° 59.73552'N, 83° 8.88720'W
                        41° 59.70438'N, 83° 8.89962'W
                        41° 59.66862'N, 83° 8.90502'W
                        41° 59.63226'N, 83° 8.90346'W
                        41° 59.59536'N, 83° 8.90190'W
                        41° 59.53830'N, 83° 8.89884'W
                        41° 59.51118'N, 83° 8.90346'W
                        41° 59.48004'N, 83° 8.92200'W
                        41° 59.43216'N, 83° 8.92278'W
                        41° 59.41716'N, 83° 8.92896'W
                        41° 59.38602'N, 83° 8.95836'W
                        41° 59.34564'N, 83° 9.01014'W
                        41° 59.32026'N, 83° 9.05886'W
                        41° 59.29428'N, 83° 9.10836'W
                        41° 59.28912'N, 83° 9.11916'W
        *       VALDCO  2.00                            ; Value of depth contour

RLOCAT
        DMPGRD                                          ; Dumping ground
                OBJNAM  FE___00250                      ; Object name
                OLDLOC  41° 57.47172'N, 83° 8.75964'W   ; Old location 41°57'28.303"N, 83° 8'45.578"N
                        41° 57.64026'N, 83° 7.95018'W
                        41° 55.39656'N, 83° 7.06956'W
                        41° 54.55926'N, 83° 9.47946'W
                        41° 57.47172'N, 83° 8.75964'W
```

```
NEWLOC  41° 57.64026'N, 83° 8.75964'W   ; New location 41°57'38.416"N, 83° 8'45.578"N
        41° 57.64026'N, 83° 7.95018'W
        41° 55.39656'N, 83° 7.06956'W
        41° 54.55926'N, 83° 9.47946'W
        41° 57.64026'N, 83° 8.75964'W
CATDPG  general dumping ground          ; Category of dumping ground
STATUS  temporary                       ; Status
```

ELECTRONIC CHART UPDATE

Cell Number: DTRT_RVR
Update Number: 001
LNM Date: 19960913
Source: USCG R&DC

Comments: This is a prototype ECU and is still undergoing development at the USCG R&DC.
This prototype contains:
Latitude & Longitude format I: Degrees & Decimal degrees
Attribute format II: All known attributes
Notation method I: S57 Abbreviations & Text translations
S57 Abbreviations for Objects & Attributes can be found in the "IHO Transfer Standard for Digital Hydrographic Data, Version 2.0, Special Publication No. 57, Appendix A"

The are 4 types of chart corrections output: INSERT, DELETE, RLOCAT and MODIFY. The basic format for an ECU Chart Corrections is as follows:

ECU Action
<tab> Object Acronym
<tab> <tab> Attribute Acronym <tab> Attribute Value
...
<tab> <tab> Attribute Acronym <tab> Attribute Value

An asterisk "*" in a MODIFY attribute field indicates the characteristic of the object that is changing. A blank attribute value represents unknown information.

Notice/Disclaimer: All users of this Electronic Chart Update (ECU) are hereby put on notice that use of this program to produce certain desired results is entirely at the risk of the user. The Government makes no representations regarding the reliability or accurateness of the ECU and specifically warns all users that the ECU is not intended for use in ANY navigational program. Further, the Government does not make any warranties, express or implied, concerning the reliability or accurateness of the data contained in the ECU; assumes no liability for the correctness of the results produced through the use of this ECU; and assumes no liability for damages, which may occur through use of this ECU

S57 Format Update		Text Translation
DELETE		
RDOCAL		; Radio calling-in point
OBJNAM	12	; Object name
LOCATE	42.009144°N, 83.122388°W	; Location 42° 0'32.918"N, 83° 7'20.597"W
ORIENT	337.00	; Orientation
TRAFIC	one-way	; Traffic flow
SCAMIN	200000	; Scale minimum
RECDAT	19960320	; Recording date
RECIND	CA,NDI,alpha	; Recording indication
SORDAT	19930312	; Source date
SORIND	CA,CHS,Chart 2121,2122,2123	; Source indication
RLOCAT		
BOYLAT		; Buoy, lateral
OBJNAM	WEST OUTER CH B 09	; Object name
OLDLOC	42.001123°N, 83.144821°W	; Old location 42° 0' 4.043"N, 83° 8'41.256"W
NEWLOC	41.997504°N, 83.145806°W	; New location 41°59'51.014"N, 83° 8'44.902"W
BOYSHP	can (cylindrical)	; Buoy shape
CATLAM	port-hand lateral mark	; Category of lateral mark
COLMAR	green	; Colour of navigational mark
MARSYS	IALA B	; Marks navigational - System of
SCAMIN	100000	; Scale minimum
RECDAT	19960320	; Recording date
RECIND	CA,NDI,alpha	; Recording indication
SORDAT	19930312	; Source date
SORIND	CA,CHS,Chart 2121,2122,2123	; Source indication
INSERT		
BOYLAT		; Buoy, lateral
OBJNAM	WEST OUT CH B 10	; Object name
LOCATE	41.997504°N, 83.142646°W	; Location 41°59'51.014"N, 83° 8'33.526"W
BOYSHP	conical (nun, ogival)	; Buoy shape
CATLAM	starboard-hand lateral mark	; Category of lateral mark
COLMAR	red	; Colour of navigational mark
MARSYS	IALA B	; Marks navigational - System of

```
                SCAMIN  100000                          ; Scale minimum
                RECDAT  19960913                        ; Recording date
                RECIND  US,USCG,alpha                   ; Recording indication

MODIFY
        BOYLAT                                          ; Buoy, lateral
                OBJNAM  WEST OUT CH B 02                ; Object name
                LOCATE  41.950728°N, 83.155596°W        ; Location     41°57' 2.621"N, 83° 9'21.456"W
                CATLAM  starboard-hand lateral mark     ; Category of lateral mark
                BOYSHP  conical (nun, ogival)           ; Buoy shape
                COLMAR  red                             ; Colour of navigational mark
                MARSYS  IALA B                          ; Marks navigational - System of
                SCAMIN  100000                          ; Scale minimum
                RECDAT  19960913                        ; Recording date
                RECIND  US,USCG,alpha                   ; Recording indication
                SORDAT  19930312                        ; Source date
                SORIND  CA,CHS,Chart 2121,2122,2123     ; Source indication
        BOYLAT                                          ; Buoy, lateral
        *       OBJNAM  WEST OUT CH LB 02               ; Object name
                LOCATE  41.950728°N, 83.155596°W        ; Location     41°57' 2.621"N, 83° 9'21.456"W
                CATLAM  starboard-hand lateral mark     ; Category of lateral mark
                BOYSHP  conical (nun, ogival)           ; Buoy shape
                COLMAR  red                             ; Colour of navigational mark
                MARSYS  IALA B                          ; Marks navigational - System of
                SCAMIN  100000                          ; Scale minimum
                RECDAT  19960913                        ; Recording date
                RECIND  US,USCG,alpha                   ; Recording indication
                SORDAT  19930312                        ; Source date
                SORIND  CA,CHS,Chart 2121,2122,2123     ; Source indication
        *       LIGHTS                                  ; Light
                        OBJNAM  WEST OUT CH LB 02       ; Object name
                        COLOUR  red                     ; Colour
                        LITCHR  flashing                ; Light characteristic
                        SIGPER  6.0                     ; Signal period
                        SIGGRP  ()                      ; Signal group

MODIFY
        DEPCNT                                          ; Depth contour
                OBJNAM  FE___05399                      ; Object name
                LOCATE  42.004310°N, 83.149306°W        ; Location     42° 0'15.516"N, 83° 8'57.502"N
                        42.003704°N, 83.149306°W
                        42.003089°N, 83.149293°W
                        42.002772°N, 83.149280°W
                        42.001792°N, 83.149138°W
                        42.000581°N, 83.148597°W
                        41.999850°N, 83.148082°W
                        41.999245°N, 83.147927°W
                        41.998630°N, 83.147773°W
                        41.997476°N, 83.147463°W
                        41.996813°N, 83.147618°W
                        41.996207°N, 83.147863°W
                        41.995592°N, 83.148120°W
                        41.995073°N, 83.148327°W
                        41.994477°N, 83.148417°W
                        41.993871°N, 83.148391°W
                        41.993256°N, 83.148365°W
                        41.992305°N, 83.148314°W
                        41.991853°N, 83.148391°W
                        41.991334°N, 83.148700°W
                        41.990536°N, 83.148713°W
                        41.990286°N, 83.148816°W
                        41.989767°N, 83.149306°W
                        41.989094°N, 83.150169°W
                        41.988671°N, 83.150981°W
                        41.988238°N, 83.151806°W
                        41.988152°N, 83.151986°W
                VALDCO  5.00                            ; Value of depth contour
                SCAMIN  100000                          ; Scale minimum
                RECDAT  19960913                        ; Recording date
                RECIND  US,USCG,alpha                   ; Recording indication
                SORDAT  19930312                        ; Source date
                SORIND  CA,CHS,Chart 2121,2122,2123     ; Source indication
        DEPCNT                                          ; Depth contour
                OBJNAM  FE___05399                      ; Object name
                LOCATE  42.004310°N, 83.149306°W        ; Location     42° 0'15.516"N, 83° 8'57.502"N
                        42.003704°N, 83.149306°W
                        42.003089°N, 83.149293°W
                        42.002772°N, 83.149280°W
                        42.001792°N, 83.149138°W
```

```
                    42.000581°N, 83.148597°W
                    41.999850°N, 83.148082°W
                    41.999245°N, 83.147927°W
                    41.998630°N, 83.147773°W
                    41.997476°N, 83.147463°W
                    41.996813°N, 83.147618°W
                    41.996207°N, 83.147863°W
                    41.995592°N, 83.148120°W
                    41.995073°N, 83.148327°W
                    41.994477°N, 83.148417°W
                    41.993871°N, 83.148391°W
                    41.993256°N, 83.148365°W
                    41.992305°N, 83.148314°W
                    41.991853°N, 83.148391°W
                    41.991334°N, 83.148700°W
                    41.990536°N, 83.148713°W
                    41.990286°N, 83.148816°W
                    41.989767°N, 83.149306°W
                    41.989094°N, 83.150169°W
                    41.988671°N, 83.150981°W
                    41.988238°N, 83.151806°W
                    41.988152°N, 83.151986°W
      *     VALDCO  2.00                          ; Value of depth contour
            SCAMIN  100000                        ; Scale minimum
            RECDAT  19960913                      ; Recording date
            RECIND  US,USCG,alpha                 ; Recording indication
            SORDAT  19930312                      ; Source date
            SORIND  CA,CHS,Chart 2121,2122,2123   ; Source indication


RLOCAT
      DMPGRD                                      ; Dumping ground
            OBJNAM  FE___00250                    ; Object name
            OLDLOC  41.957862°N, 83.145994°W      ; Old location 41°57'28.303"N, 83° 8'45.578"N
                    41.960671°N, 83.132503°W
                    41.923276°N, 83.117826°W
                    41.909321°N, 83.157991°W
                    41.957862°N, 83.145994°W
            NEWLOC  41.960671°N, 83.145994°W      ; New location 41°57'38.416"N, 83° 8'45.578"N
                    41.960671°N, 83.132503°W
                    41.923276°N, 83.117826°W
                    41.909321°N, 83.157991°W
                    41.960671°N, 83.145994°W      ; Location
            CATDPG  general dumping ground        ; Category of dumping ground
            STATUS  temporary                     ; Status
            SCAMIN  150000                        ; Scale minimum
            RECDAT  19960913                      ; Recording date
            RECIND  US,USCG,alpha                 ; Recording indication
            SORDAT  19930312                      ; Source date
            SORIND  CA,CHS,Chart 2121,2122,2123   ; Source indication
```

ELECTRONIC CHART UPDATE

Cell Number: DTRT_RVR
Update Number: 001
LNM Date: 19960913
Source: USCG R&DC

Comments: This is a prototype ECU and is still undergoing development at the USCG R&DC.
This prototype contains:
Latitude & Longitude format I: Degrees & Decimal degrees
Attribute format I: S57 required ONLY
Notation method II: Text ONLY (no S57 abbreviations)
S57 Abbreviations for Objects & Attributes can be found in the "IHO Transfer Standard for Digital Hydrographic Data, Version 2.0, Special Publication No. 57, Appendix A"

The are 4 types of chart corrections output: INSERT, DELETE, RLOCAT and MODIFY. The basic format for an ECU Chart Corrections is as follows:

ECU Action
<tab> Object Name
<tab> <tab> Attribute Name <tab> Attribute Value
...
<tab> <tab> Attribute Name <tab> Attribute Value

An asterisk "*" in a MODIFY attribute field indicates the characteristic of the object that is changing. A blank attribute value represents unknown information.

Notice/Disclaimer: All users of this Electronic Chart Update (ECU) are hereby put on notice that use of this program to produce certain desired results is entirely at the risk of the user. The Government makes no representations regarding the reliability or accurateness of the ECU and specifically warns all users that the ECU is not intended for use in ANY navigational program. Further, the Government does not make any warranties, express or implied, concerning the reliability or accurateness of the data contained in the ECU; assumes no liability for the correctness of the results produced through the use of this ECU; and assumes no liability for damages, which may occur through use of this ECU

Objects & Attributes	Attribute Values
DELETE	
Radio calling-in point	
Object name:	12
Location:	42.009144°N, 83.122388°W
Orientation:	337.0
Traffic flow:	one-way
RLOCAT	
Buoy, lateral	
Object name:	WEST OUTER CH B 09
Old location:	42.001123°N, 83.144821°W
New location:	41.997504°N, 83.145806°W
Buoy shape:	can (cylindrical)
Category of lateral mark:	port-hand lateral mark
Colour of navigational mark:	green
INSERT	
Buoy, lateral	
Object name:	WEST OUT CH B 10
Location:	41.997504°N, 83.142646°W
Buoy shape:	conical (nun, ogival)
Category of lateral mark:	starboard-hand lateral mark
Colour of navigational mark:	red
MODIFY	
Buoy, lateral	
Object name:	WEST OUT CH B 02
Location:	41.950728°N, 83.155596°W
Category of lateral mark:	starboard-hand lateral mark
Buoy shape:	conical (nun, ogival)
Colour of navigational mark:	red
Buoy, lateral	
* Object name:	WEST OUT CH LB 02
Location:	41.950728°N, 83.155596°W
Category of lateral mark:	starboard-hand lateral mark

```
            Buoy shape:                          conical (nun, ogival)
            Colour of navigational mark:         red
      *     Light
                  Object name:                   WEST OUT CH LB 02
                  Colour                         red
                  Light characteristic:          flashing
                  Signal period                  6.0
                  Signal group                   ()

MODIFY
      Depth contour
            Object name:                         FE___05399
            Location:                            42.004310°N, 83.149306°W
                                                 42.003704°N, 83.149306°W
                                                 42.003089°N, 83.149293°W
                                                 42.002772°N, 83.149280°W
                                                 42.001792°N, 83.149138°W
                                                 42.000581°N, 83.148597°W
                                                 41.999850°N, 83.148082°W
                                                 41.999245°N, 83.147927°W
                                                 41.998630°N, 83.147773°W
                                                 41.997476°N, 83.147463°W
                                                 41.996813°N, 83.147618°W
                                                 41.996207°N, 83.147863°W
                                                 41.995592°N, 83.148120°W
                                                 41.995073°N, 83.148327°W
                                                 41.994477°N, 83.148417°W
                                                 41.993871°N, 83.148391°W
                                                 41.993256°N, 83.148365°W
                                                 41.992305°N, 83.148314°W
                                                 41.991853°N, 83.148391°W
                                                 41.991334°N, 83.148700°W
                                                 41.990536°N, 83.148713°W
                                                 41.990286°N, 83.148816°W
                                                 41.989767°N, 83.149306°W
                                                 41.989094°N, 83.150169°W
                                                 41.988671°N, 83.150981°W
                                                 41.988238°N, 83.151806°W
                                                 41.988152°N, 83.151986°W
            Value of depth contour               5.00
      Depth contour
            Object name:                         FE___05399
            Location:                            42.004310°N, 83.149306°W
                                                 42.003704°N, 83.149306°W
                                                 42.003089°N, 83.149293°W
                                                 42.002772°N, 83.149280°W
                                                 42.001792°N, 83.149138°W
                                                 42.000581°N, 83.148597°W
                                                 41.999850°N, 83.148082°W
                                                 41.999245°N, 83.147927°W
                                                 41.998630°N, 83.147773°W
                                                 41.997476°N, 83.147463°W
                                                 41.996813°N, 83.147618°W
                                                 41.996207°N, 83.147863°W
                                                 41.995592°N, 83.148120°W
                                                 41.995073°N, 83.148327°W
                                                 41.994477°N, 83.148417°W
                                                 41.993871°N, 83.148391°W
                                                 41.993256°N, 83.148365°W
                                                 41.992305°N, 83.148314°W
                                                 41.991853°N, 83.148391°W
                                                 41.991334°N, 83.148700°W
                                                 41.990536°N, 83.148713°W
                                                 41.990286°N, 83.148816°W
                                                 41.989767°N, 83.149306°W
                                                 41.989094°N, 83.150169°W
                                                 41.988671°N, 83.150981°W
                                                 41.988238°N, 83.151806°W
                                                 41.988152°N, 83.151986°W
      *     Value of depth contour               2.00

RLOCAT
      Dumping ground
            Object name:                         FE___00250
            Old location:                        41.957862°N, 83.145994°W
                                                 41.960671°N, 83.132503°W
                                                 41.923276°N, 83.117826°W
                                                 41.909321°N, 83.157991°W
                                                 41.957862°N, 83.145994°W
```

New location:	41.960671°N, 83.145994°W 41.960671°N, 83.132503°W 41.923276°N, 83.117826°W 41.909321°N, 83.157991°W 41.960671°N, 83.145994°W
Category of dumping ground:	general dumping ground
Status:	temporary

APPENDIX K - DETAILED ANALYSIS OF QUESTIONNAIRE RESPONSIS (July 1997)

1996 Field Trial on ENC Updating

Data Description

Personal Background

- Majority of respondents (64%) regularly sailed bulb/ore carriers, the remaining respondents (36%) sailed on buoy tenders.
- The most common vessel sailed (64%) were large (150m and up) in size, with small (0-75m) at (14%), medium (75 - 150m) at 26%.
- Reported familiarity with computers: none 9%, novice 41%, intermediate 36%, experienced 9%, expert 5%.
- Reported position normally occupied aboard the vessel: Master 14%, Chief 5%, 1st Officer18%, 2nd Officer 18%, 3rd Officer 18%, Quarter Master 18%, Bridge Officer 18%.
- Reported highest position occupied aboard any vessel: Master 23%, Chief 5%, 1st Officer 5%, 2nd Office 36%, 3rd Officer 9%, Quarter Master 5%, Bridge Officer 18%.
- Age groups: 50-59 9%, 40-49 27%, 30-39 41%, 20-29 23%

Points - Questions 11,30,31.

- I feel comfortable making changes (applying updates directly) to the System Electronic Navigation Chart (SENC)

Response	Probability
Disagree	9%
Agree	59%
Strongly agree	32%

- Currently there are two procedures by which Manual Updates are applied to the SENC: Overlay- in which the Manual Update is applied only graphically (i.e., there are no connections to the underlying attribute information); Incorporated - in which the Manual Update is integrated into the SENC.

I feel that Manual Updates should be an overlay, and not directly applied to the SENC.

Response	Probability
Strongly Disagree	38%
Disagree	43%
Agree	10%
Strongly agree	10%

Lines and Areas - Questions 15,28,29,45 .

- Manual Updates for lines and areas objects will sometimes result in large changes to the SENC. I am comfortable with this level of Mariner-controllable change of the SENC. (Before)

Response	Probability
Strongly Disagree	9%
Disagree	14%
Agree	45%
Strongly agree	32%

- I found the implementation for **Manual Updates of Lines** I used today to be straightforward.

Response	Probability
Agree	58%
Strongly agree	42%

- I found the implementation for **Manual Updates of Areas** I used today to be straightforward.

Response	Probability
Agree	45%
Strongly agree	55%

- Manual Updates for lines and areas objects will sometimes result in large changes to the SENC. I am comfortable with this level of Mariner-controllable change of the SENC. (After)

Response	Probability
Disagree	9%
Agree	68%
Strongly agree	23%

Procedure for Automatic Updates to replace Manual Updates - Question 16,46.

- When an Official (i.e., Automatic) Update is received for objects which have already been updated manually, how should those Manual Updates be cleared from the ECDIS to prepare for the application of the Official Update:

Response	Probability
Manual Updates should be cleared by the mariner	14%
Official Updates should automatically replace Manual Updates	77%
Other	9%

- When an Official (i.e., Automatic) Update is received for objects which have already been updated manually, how should those Manual Updates be cleared from the ECDIS to prepare for the application of the Official Update: (AFTER)

Response	Probability
Manual Updates should be cleared by the mariner	23%
Official Updates should automatically replace Manual Updates	64%
Other	14%

The Format of ECU

Question 17,18,32,33,34,35,36.

- With which Lat-Long format are you most comfortable: (BEFORE)

Response	Probability
degree minutes and decimal minutes.	55%
degrees and decimal degrees.	32%
other	14%

- Lat-long formats in the ECU may be in degrees and decimal degrees. I find this to be: (BEFORE)

Response	Probability
Objectionable	18%
Acceptable	59%
Highly Acceptable	3%

- What information should be included in the Electronic Chart Update (ECU):

Response	Probability
Only supply mandatory attributes.	55%
Supply mandatory attributes, and all information available.	45%

- With which Lat-Long format are you most comfortable: (AFTER)

Response	Probability
degree minutes and decimal minutes.	48%
degrees and decimal degrees.	29%
other	24%

- Lat-long formats in the ECU may be in degrees and decimal degrees. I find this to be:

Response	Probability
Highly Objectionable	9%
Objectionable	23%
Acceptable	55%
Highly Acceptable	14%

- The manual ECU should contain which of the following:

Response	Probability
only the text equivalent of the computer readable data	27%
both the computer readable data as well as its text equivalent	73%

- The manual ECU will most likely have both the computer readable data and its text equivalent, I find this to be:

Response	Probability
Objectionable	9%
Acceptable	55%
Highly Acceptable	36%

Verification and Error Checking - Question 19,37,38,39.

- In Manual Updating, the mariner should be provided which of the following methods to verify the information in the electronic chart update (ECU).

Response	Probability
a textual window containing entered update information.	18%
a graphical check depicting update on chart.	27%
a textual window as well as a graphical check.	50%
Other	5%

- In Manual Updating, the mariner should be provided which of the following methods to verify the information in the electronic chart update (ECU).

Response	Probability
A textual window containing entered update information.	18%
A graphical check depicting update on chart.	5%
A textual window as well as a graphical check.	77%

- The mariner should be provided the facility to enter the rejected object(s) in a log stating why the object was unacceptable.

Response	Probability
Strongly Disagree	9%
Disagree	18%
Agree	41%
Strongly agree	32%

- I would like a screen to allow the logging of a remark as to why I have rejected the Manual Update?

Response	Probability
Strongly Disagree	5%
Disagree	23%
Agree	45%
Strongly agree	27%

How Colors and Symbols are Displayed

Question 12,40,20,21,22,23.

- The standard states that "..Manual Updates should be distinguishable from the ENC information and its Official Updates, but not affect display legibility.." Which of the following best meets these requirements:

Response	Probability
the object is displayed in standard colors and symbols, and can be highlighted on demand.	73%
the object is at all times displayed in the color orange.	27%

- Which of the following methods of displaying inserted objects best meets these requirements for Manual Updates stated above:

Response	Probability
the object is displayed in standard colors and symbols, and can be highlighted on demand.	95%
the object is at all times displayed in the color orange.	5%

- Which of the following methods of displaying deleted objects best meets these requirements for Manual Updates stated above:

Response	Probability
the object is removed from display, but would show up when highlighted on demand.	86%
the object is displayed in the original color with orange slash over symbol.	14%

- Which of the following methods of displaying modified objects best meets these requirements for Manual Updates stated above:

Response	Probability
the original object is removed from display, the modified object is displayed in standard colors and symbols and both can be highlighted on demand (i.e, orange circle to highlight new object and orange slash to highlight old object).	91%
the original object is displayed with an orange slash through it, and modified objects are displayed in orange, offset by a user specified distance.	9%

- Which of the following methods of displaying relocated objects best meets these requirements for Manual Updates stated above:

Response	Probability
the original object is no longer displayed, the moved object is displayed in standard colors and symbols at the new location and both can be highlighted on demand (i.e. orange circle)	91%
the original object is displayed with an orange slash through it, and moved objects are displayed at the new location in orange.	9%

- The standard states that "..Manual Updates should be distinguishable from the ENC information and its Official Updates, but not affect display legibility.." Which of the following best meets these

Response	Probability
the object is displayed in standard colors and symbols, and can be highlighted on demand.	91%
Other	9%

Implementation and Uses of Highlighting

Question 13,14,25,26,27,41,42.

- The standard states that "..Manual Updates should be distinguishable from the ENC information and its Official Updates..." This has usually been interpreted to mean that the updated objects should remain Orange at all times. I would consider these requirements met

Response	Probability
Strongly Disagree	9%
Disagree	5%
Agree	64%
Strongly agree	23%

- Which of the following methods of highlighting would be most effective to distinguish manual Update information from the ENC and its Official Updates.

Response	Probability
Manually updated objects are displayed in orange at all times.	19%
All updates are circled or slashed in orange only upon request.	14%
Information about the object is available by double-clicking on the object	19%
Choices b and c together.	38%
Other	10%

- Which of the following methods of highlighting would be most effective to distinguish Manual Update information from the ENC and its Official Updates.

Response	Probability
manually updated objects are displayed in orange at all times.	11%
The object is circled or slashed in orange only upon request.	47%
Information about the object is available by double-clicking	

on the object	11%
choices b and c together.	21%
Other	11%

- Textual information should always accompany the highlight display.

Response	Probability
Strongly Disagree	11%
Disagree	16%
Agree	58%
Strongly agree	16%

- The ability to retrieve update as well as general information by clicking on manually updated objects sufficiently meets the requirement to distinguish Manual Update information from the ENC and its Official Updates.

Response	Probability
Strongly Disagree	6%
Agree	65%
Strongly agree	29%

- The standard states that "..Manual Updates should be distinguishable from the ENC information and its Official Updates..." This has usually been interpreted to mean that the updated objects should remain Orange at all times. I would consider these required

Response	Probability
Strongly Disagree	5%
Disagree	14%
Agree	52%
Strongly agree	29%

- Textual information should always accompany the highlight display.

Response	Probability
Disagree	14%
Agree	50%
Strongly agree	36%

Logging Information

Question 24,43,44.

- It should only be possible for a mariner to get in and out of "updating mode" by supplying a user id and password.

Response	Probability
Disagree	5%
Agree	23%
Strongly agree	73%

Before and After Grouping

Questions 11,30;13,41;14,25;14,25;16,46;17,33;18,34;19,37;26,42.

11. I feel comfortable making changes (applying updates directly) to the System Electronic Navigation Chart (SENC).				30. I feel comfortable making changes (applying updates directly) to the System Electronic Navigation Chart (SENC).			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob
B) Disagree	2	0.09091	0.09091	A)Strongly Disagree	1	0.04545	0.04545
C) Agree	13	0.59091	0.68182	C) Agree	11	0.5	0.54545
D) Strongly agree	7	0.31818	1	D) Strongly agree	10	0.45455	1

12 The standard states that "..Manual Updates should be distinguishable from the ENC information and its Official Updates, but not affect display legibility.." Which of the following best meets these requirements:				40 The standard states that "..Manual Updates should be distinguishable from the ENC information and its Official Updates, but not affect display legibility.." Which of the following best meets these requirements:			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob
A) the object is displayed in standard colors and symbols, and can be highlighted on demand.	16	0.72727	0.72727	A) the object is displayed in standard colors and symbols, and can be highlighted on demand.	20	0.90909	0.90909
B) the object is at all times displayed in the color orange.	6	0.27273	1	C) other	2	0.09091	1

13 The standard states that "..Manual Updates should be distinguishable from the ENC information and its Official Updates..." This has usually been interpreted to mean that the updated objects should remain Orange at all times. I would consider these req				41 The standard states that "..Manual Updates should be distinguishable from the ENC information and its Official Updates..." This has usually been interpreted to mean that the updated objects should remain Orange at all times.			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob
A) Strongly Disagree	2	0.09091	0.09091	A) Strongly Disagree	1	0.04762	0.04762
B) Disagree	1	0.04545	0.13636	B) Disagree	3	0.14286	0.19048

C) Agree	14	0.63636	0.77273	C) Agree	11	0.52381	0.71429+
D) Strongly agree	5	0.22727	1	D) Strongly agree	6	0.28571	1

14 Which of the following methods of highlighting would be most effective to distinguish manual Update information from the ENC and its Official Updates.				25 Which of the following methods of highlighting would be most effective to distinguish manual Update information from the ENC and its Official Updates.			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob
A) manually updated objects are displayed in orange at all times.	4	0.19048	0.19048	A) manually updated objects are displayed in orange at all times.	2	0.10526	0.10526
B) all updates are circled or slashed in orange only upon request.	3	0.14286	0.33333	B) all updates are circled or slashed in orange only upon request.	9	0.47368	0.57895
C) information about the object is available by double-clicking on the object	4	0.19048	0.52381	C) information about the object is available by double-clicking on the object	2	0.10526	0.68421
D) choices b and c together.	8	0.38095	0.90476	D) choices b and c together.	4	0.21053	0.89474
E) other	2	0.09524	1	E) other	2	0.10526	1

15 Manual Updates for lines and areas objects will sometimes result in large changes to the SENC. I am comfortable with this level of Mariner-controllable change of the SENC.				45 Manual Updates for lines and areas objects will sometimes result in large changes to the SENC. I am comfortable with this level of Mariner-controllable change of the SENC.			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob
A) Strongly Disagree	2	0.09091	0.09091	B) Disagree	2	0.09091	0.09091
B) Disagree	3	0.13636	0.22727	C) Agree	15	0.68182	0.77273
C) Agree	10	0.45455	0.68182	D) Strongly agree	5	0.22727	1
D) Strongly agree	7	0.31818	1	Total	22		

16 When an Official (i.e., Automatic) Update is received for objects which have already been updated manually, how should those Manual	46 When an Official (i.e., Automatic) Update is received for objects which have already been updated manually, how should those Manual

Updates be cleared from the ECDIS to prepare for the application of the Official Update:				Updates be cleared from the ECDIS to prepare for the application of the Official Update:			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob
A) Manual Updates should be cleared by the mariner.	5	0.22727	0.22727	A) Manual Updates should be cleared by the mariner.	3	0.13636	0.13636
B) Official Updates should automatically replace Manual Updates, requiring no clearing from the mariner.	14	0.63636	0.86364	B) Official Updates should automatically replace Manual Updates, requiring no clearing from the mariner.	17	0.77273	0.90909
C) Other	3	0.13636	1	C) Other	2	0.09091	1

17 With which Lat-Long format are you most comfortable:				33 With which Lat-Long format are you most comfortable:			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob
A) degree minutes and decimal minutes.	12	0.54545	0.54545	A) degree minutes and decimal minutes.	10	0.47619	0.47619
B) degrees and decimal degrees.	7	0.31818	0.86364	B) degrees and decimal degrees.	6	0.28571	0.7619
C) other	3	0.13636	1	C) other	5	0.2381	1

18 Lat-long formats in the ECU may be in degrees and decimal degrees. I find this to be:				34 Lat-long formats in the ECU may be in degrees and decimal degrees. I find this to be:			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob
B) Objectionable	4	0.18182	0.18182	A) Highly Objectionable	2	0.09091	0.09091
C) Acceptable	13	0.59091	0.77273	B) Objectionable	5	0.22727	0.31818
				C) Acceptable	12	0.54545	0.86364
D) Highly Acceptable	5	0.22727	1	D) Highly Acceptable	3	0.13636	1

19 In Manual Updating, the mariner should be provided which of the following methods to verify the information in the electronic chart update (ECU).				37 In Manual Updating, the mariner should be provided which of the following methods to verify the information in the electronic chart update (ECU).			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob

A) a textual window containing entered update information.	4	0.18182	0.18182	A) a textual window containing entered update information.	4	0.18182	0.18182
B) a graphical check depicting update on chart.	6	0.27273	0.45455	B) a graphical check depicting update on chart.	1	0.04545	0.22727
C) a textual window as well as a graphical check.	11	0.5	0.95455	C) a textual window as well as a graphical check.	17	0.77273	1
D) Other	1	0.04545	1				

26 Textual information should always accompany the highlight display. (28)				42 Textual information should always accompany the highlight display. (28)			
Before	Count	Prob	Cum Prob	**After**	Count	Prob	Cum Prob
A) Strongly Disagree	2	0.10526	0.10526	B) Disagree	3	0.13636	0.13636
B) Disagree	3	0.15789	0.26316	C) Agree	11	0.5	0.63636
C) Agree	11	0.57895	0.84211	D) Strongly agree	8	0.36364	1
D) Strongly agree	3	0.15789	1				

II) Analysis

Effects of Personal Background Data on Groups of Special Importance.

1) Before and After Grouping

Questions 11,30;13,41;14,25;14,25;16,46;17,33;18,34;19,37;26,42.

2) How Colors and Symbols are Displayed

Question 12,40,20,21,22,23.

3) Implementation of Highlighting

Question 13,14,25,26,27,41,42

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